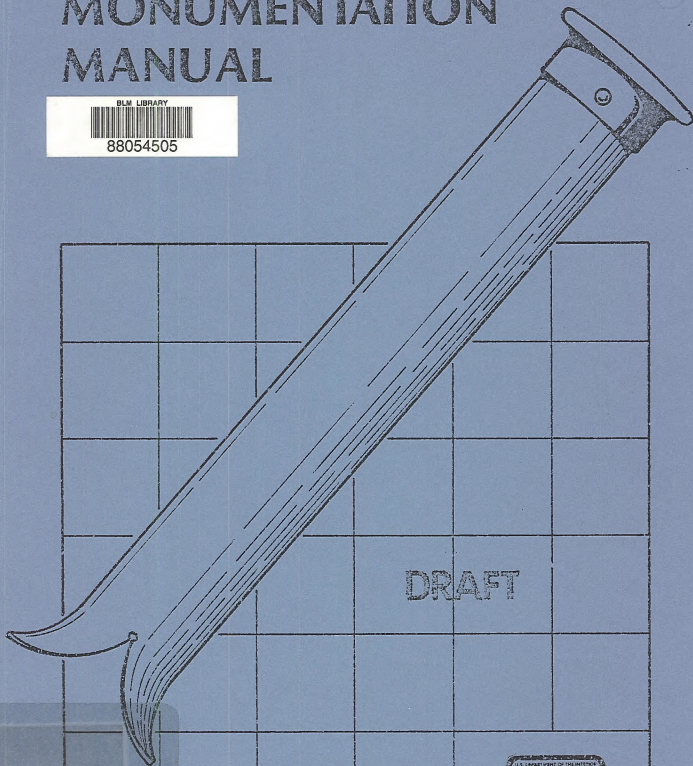


CADASTRAL SURVEY MONUMENTATION MANUAL



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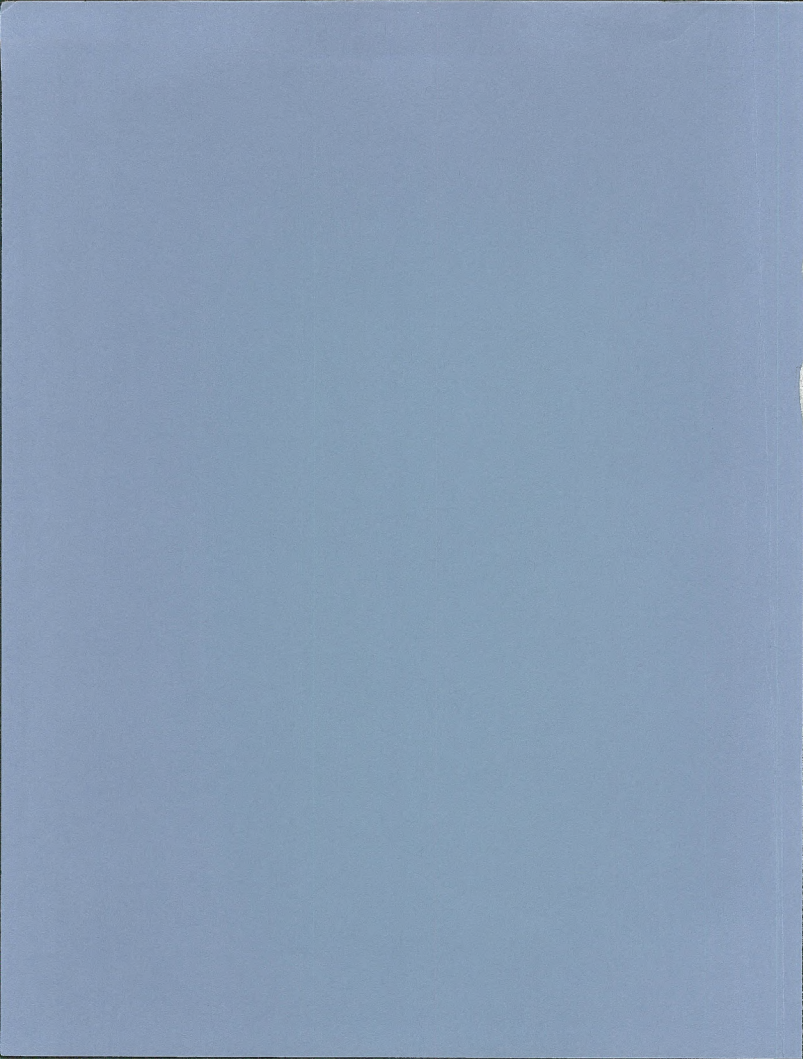


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CHAPTER I.

INTRODUCTION, SCOPE
AND PURPOSE

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Introduction, Scope and Purpose

I. Introduction:

Many publications have been written on various phases of surveying activities, but few publications have ever been written on the subject of monumentation. Yet this is probably the most important task that the surveyor performs. The monument is the only evidence that the surveyor leaves in the field to show evidence of his labor. Great importance is placed on monumentation evidence. A court of law will hold ground monumentation evidence in higher priority over all written records that may be produced. This includes technical records relating to bearings and lengths of lines.

The role of survey and monumentation has been closely associated with the progress of civilization. A very early record found in the Tigris-Euphrates Valley spoke of war between the city of Lagash and a neighboring city because a boundary stone had been moved. As the Hebrew people enter the promised land (Old Testament times) from Egypt, high importance was placed on landmarks and boundaries. During the early Middle Ages, English Common Law placed a very high value on real property rights, landmarks, and boundaries. During this period in history penalties for damaging property or moving boundaries were more severe than penalties for taking human life.

George Washington, a graduate of William and Mary College, Williamsburg, Virginia was a surveyor during Colonial times and established boundaries and set landmarks (corner monuments). Property rights of individuals are protected in the United States by the First and Fourteenth Amendments to the Constitution. Again, boundary lines established by field monumentation evidence outweighs all other evidence and written documents that may be presented in a court of law. Monumentation and monumentation procedures are of the highest importance.

One of the most fundamental principles of surveying law is the absolute permanency of public land surveys when the lines have been officially established. The law further provides that the original corners established shall forever remain fixed in position. This is true even where discrepancies may have passed undetected prior to the acceptance of the survey.

During early surveys in the United States, corners were marked by setting wooden posts at the proper locations. When surveying on the prairie or grassland, a pit was dug or a mound of dirt was constructed to denote each corner. When surveying in forest areas, trees were marked and recorded as witness trees in the field notes. The size of the tree was recorded (DBH, diameter at breast height) as well as the type of tree. In other areas stones or rocks were piled up to denote corner marks. As time passed, the wooden markers would often rot away and the rains would fill in the pits. Trees would be cut and the mounds of dirt would sometimes disappear due to rain and flooding conditions.

It was soon decided that a more permanent type of monument was needed to mark public land boundaries. So in 1908, Congress provided the funding for purchasing more durable metal monuments to mark public lands. This was the beginning of the "regulation iron post". Although it has been improved and changed over the years, this was its beginning. At this same time a penalty was assessed for defacing the monument or any marks relating to the survey.

If more time were devoted to making corner markers more permanent, the very expensive research in regards to reestablishing lost corners would be avoided. The "Manual of Instructions for the Survey of the Public Lands of the United States" approved in 1930 by Mr. C.C. Moore, Commissioner of the General Land Office, makes the following statement:

"The legal significance of the original monuments, makes it mandatory upon the engineer to exercise constant diligence in the workmanlike construction of lasting corner, and alertness in skillfully connecting the same with natural objects or improvements, to the end that the greatest possible permanency may be secured for the public land surveys."

In 1908, the General Land Office adopted the regulation iron post for monumentating public land surveys. Although metallurgical advancements have been made and new metals such as stainless steel are now being used, the basic design of the original monument remains unchanged to the present time.

Purpose:

The purpose of this manual is not only to give some important history of monumentation, but to show how the Bureau of Land Management intends to maintain high quality monuments in the future. From the early General Land Office days to the present, very high priority has been placed on field evidence of the original surveyor. The Congress of the United States has also placed a very high priority on making survey corners as permanent as possible.

Scope:

This document will cover all phase of cadastral survey monumentation as administered by the Bureau of Land Management. All officially approved monuments will be described and discussed in detail. Both materials and monument design and dimensions will be thoroughly covered. Soil conditions (chemical reactions) as well as temperature extremes and soil moisture will be discussed. Both installation procedures as well as cap marking will be reviewed.

Quality control programs are to be initiated to cover monument procurement as well as to insure proper installation in the field. BLM will maintain their existing monument test beds for monitoring new and existing materials. Newly proposed test beds for highly corrosive soils as well as cold (low temperature) climates will be discussed.

The need for a continuing search for improved monument materials will be addressed. In conclusion this manual will cover the various types of both technical and routine reports that must be written. Properly maintained records will be required to document field inspections, test bed inspections, and general problem areas.



CHAPTER II.

HISTORY

A History of Monumentation

I. Introduction

Survey markers and monuments have had both an important but yet almost invisible history. Monuments have been set for a multitude of applications including: topographic and hydrographic measurements, geodetic control, and cadastral or boundary marking. The last type mentioned (cadastral), and to a small extent, geodetic monumentation, will be the focus of this chapter.

Monuments have come in all shapes, sizes, and materials. Some of the types of monuments include: fences, walls, buildings, trees, stumps, buggy and car axles, beer cans, bottles, wood stakes, bottle caps, stone, metal pipes, shotgun barrels, and steel reinforcing rod to name a few.

This will be a brief overview of the development and use of monuments from the earliest of recorded time to the present, as the U.S. PLSS enters its third century.

II. First Recorded Use of Boundaries

Jacob and his neighbor, Laban, are described in the Old Testament as establishing the first boundary marker (Genesis, Chapter 31: verses 45-48):

'Then Jacob took a stone and set it up as a memorial Pillar. Jacob said to his kinsman, 'Gather some stones.' And they gathered stones, made a heap... 'God is a witness between you and me.'

Laban continued, 'Note this heap and this memorial Pillar I have set up between you and me. This heap is a witness, and the memorial is a witness that I will not go beyond this heap toward you, and that you shall not go beyond this heap and memorial toward me to do harm.'

Until Jacob, the owners of land believed the Possessing of land to be a gift of God, where 'God would be their witness.'

None of Jacob's boundary markers survive today. In Jacob's time there were no courts or law to solve problems between members of society, so rules of living were established by God in the Old Testament. As time passed and people farmed the land, conflicts would occur, and by the prophets, God exposed the supernatural laws of boundaries, by which today's laws are governed.

In biblical times property and its boundaries were not only important but also sacred:

'Thou shall not remove the neighbor's landmarks which they of old time have set in thine inheritance which thou shalt inherit in the land that the lord thy God giveth thee to possess it.'

Deuteronomy 19:14

'Remove not the ancient landmark, which thy fathers have set.'
Proverbs 22:28

'Cursed be he that removeth his neighbor's landmark. And all the people shall say, Amen.'
Deuteronomy 27:17

'Remove not the old landmark; and enter not into the fields of the fatherless.'
Proverbs 23:10

Boundaries were not an integral part of everyday life. They were the key to peace between neighbors, whether local, or far.

III. Early Uses of Survey Monuments

The Egyptians conceived written records for individual tracts and Parcels of land. Much of this initially resulted out of necessity as Egypt, being an arid country, was susceptible to annual flooding by the Nile River. After each yearly flood, a resurvey was made to determine ownership of the lands by the replacing of monuments to their original locations. To maintain a level of stability and security, records of ownership were not, only placed with the tax records but also in the royal treasury.

As history progressed, boundaries and boundary stones continued to play an important role in the discovery, conquest, and expansion of lands. Boundary stones (monuments) in ancient Mesopotamia were as important as the PLSS metal pipe monuments are today. One fine example of an ancient type of survey monument exists today, but only in museums. This is the KUDURRU (pronounced kood-oo-rue) or boundary stone. These were used from 1500 BC to 600 BC. The kudurrus were copies of the official deed to land written on clay tablets which were marked as official and proper by the stamping of the royal seal. The boundary stone (kudurru) was kept by the owner as proof of ownership and was not actually set to mark a boundary. The kudurru contained the record of ownership, the name of the surveyor, sale price, and symbols for the protection of the boundaries and for the harm of those (through curses) who might disturb the owner's rights to his land. Some of the curses invoked on the boundary stones (kudurrus) were severe:

May Gula, the mighty physician, put a grievous sickness in his body, so that he may pass light and dark blood like water.'

May Nabu, the exalted minister, appoint him days of scarcity and drought as his destiny.'

May Sin, the light of the bright heavens fill his body with leprosy that never departs, clothe his whole body, so that he may not be clean till the day of his death, but must lie down like a wild ass at the outer wall of the city.'

WOW! A little more graphic than \$250 fine for disturbing this mark!

Ancient records mention many land disputes. A war was fought in the Tigris-Euphrates Valley over the movement of a boundary stone. The Romans had a special god: Terminus, the god of boundary stones. A formal religious ceremony consisted of the setting of a stone or post in the ground. First, a hole was dug and a fire lighted; a victim (perhaps a disgruntled rod man?) was sacrificed and the blood poured into the hole, together with incense and fruits, honey and wine, and the ashes of the sacrifice. Then the boundary stone which has previously been appointed and crowned with garlands, was placed upon the hot ashes and fixed in the ground. Any one who removed a boundary stone was accursed and might be put to death; later a fine was substituted for the death penalty. On February 23rd (the end of the old Roman year) the festival called Terminalia (honoring the boundary stone, or termini, not the god Terminus) was held. The owners of adjacent lands assembled at the common boundary stone and garlanded each his own side of the stone. An altar was set up and offerings of cakes, corn, honey, and wine were made. Later a lamb or a sucking pig was sacrificed. The proceeding closed with songs to the gods and general merrymaking, in which all members of the family and the servants took part.

IV. The Beginning of Modern Development of Boundaries.

Modern development of boundaries began in 1066 when William of Normandy conquered England. He established a strong central government with himself as King. He considered all of the lands as his personal property.

In 1086, William arranged for a total and complete inventory of his wealth. This accounting was accumulated in two books, better known as the "DOMESDAY BOOK", with 'DOOM' meaning judgment or earth. This accounting included the names of all the tenants and subtenants of his lands, value of the land, value of all property including livestock, and details of all his property including the number of his servants.

Feudalism flourished under William with his tenure over all lands assured. Statements such as 'Possession is 9/10ths of the law' and 'A man's home is his castle' have been traced back to William's reign. Monumentation during this time varied from marked trees, and stones to natural boundaries such as rivers, edges of forests, etc.

V. Colonial America

As soon as the first settlers reached America - the new world, surveying and platting began in earnest. A major problem from the beginning was the granting of huge areas of land by foreign powers to their many 'friends'. Many times these 'grants' overlapped causing confusion, concern, and controversy.

In 1620, surveyors began to lay out lands in the Jamestown colony. During the years that followed, new surveys were started up and down the eastern coast. The major portions of this work were done in what was then called New Netherlands (now New York), Maryland, and Delaware.

Much of the early problems encountered in surveying during the 17th and early 18th century in the original thirteen states has only gotten worse as land titles have been updated in modern times. The culprit being 'metes and bounds' survey. An entire book has been written concerning such problems using the appropriate title 'DEED DESCRIPTIONS I HAVE KNOWN BUT COULD HAVE DONE WITHOUT' by Donald Wilson. An entire chapter is included on "MONUMENTATION". Such examples given include: '...thence South sixty seven degrees east thirty five rod and twenty links by the remains of an old fence to a cluster of Newfound Oak Sprouts...' (1838), '...following a line just North of a large mud hole. '...sixty-eight rods and eighteen links to a hole in the ground...'; '...crossing a meadow to a white Oak tree called the Dinner tree...'; '...to a stake and stones by a log that formerly fell across Policy Brook...' (1864); '...to a hemlock stump (now long gone...'; and finally, '...thence westerly to a grape vine...'

Even the early Indians placed a value and meaning on boundaries: CHABANAKONGKONIUCK near Worcester, Massachusetts is translated to: "You fish on your side, I fish on my side; nobody fish in the middle - no trouble.

VI. Modern Surveying

Modern surveyings, as we know it, came into existence with the 'LAND ACT OF 1785' (the NORTHWEST ORDINANCE), otherwise known as the start of the Public Land Survey System (PLSS). Through the enactment of the rectangular survey a fair and consistent means of measuring land was developed. However, this system was actually an ancient concept having been developed by the Romans sometime between the fall of Carthage in 140 BC and 111 BC (after the last of the Punic Wars). This rectangular land survey system was known as 'CENTURIATIO'. The Germans also have had a system of rectangular surveys for over 400 years.

Through the history of surveying the original survey monuments were stones or concrete pillars. Later, usually because these items were either not readily available or too awkward to use, other materials were introduced as monuments. These included the tree and tree stump (which can be found today in the 'bearing tree'), the wood stake (which proved to be as bad as the 'big mud hole'), and under the Act of May 27, 1908 (35 Stat. 347), a 'REGULATION' iron post was adopted for monumenting the Public land surveys. Many other types have evolved including plastic and fiberglass monuments for the ultimate in below ground durability, the 'deep' rod mark (originally a copper clad steel rod and now composed either of aluminum or stainless steel); the 'helix' (an auger-style control mark); as well as many others. Even the 'REGULATION IRON POST' has undergone changes. 'Regulation' monuments may now be composed of aluminum and stainless steel as well as iron.

VII. Conclusion

As property values increase and government budgets become tighter new ways are being explored to better account for more accurate tax assessment of land. Through modern computerized data base systems this is being achieved. Unfortunately, as mentioned in the beginning of this chapter where it was stated 'Survey markers and monuments have had both an important but yet INVISIBLE history, one thing about monuments is true; they are not readily noticeable to the Public's eye. The county sheriff on patrol in his squad car, or the local fire department rushing to a big fire are visible dispersements of our tax dollars. However, the many boundary and control monuments that these vehicles travel over to get to their destinations are not. Hopefully with the introduction of new technology such as GPS and individual navigation systems for automobiles, as well as new technological advances in the survey monument itself, survey monuments can be set without resorting to ancient curses to gain respect.

A Sampling of the Many Things Called
A Survey Monument

Stones	Trees
Creek	Mound
Railroad Iron	Buggy Axle
Pit	Wagon Spindle
Charred Wood Stake	Well Point
Cement Block	Gas Pipe
"X" on a Boulder	Wagon Skein
Shotgun Barrel	Cannon Ball
Steel Beer Can	Wood Stump
Pottery	Brick
'Nest of Rock'	Iron Pipe
Ledge of Granite	Flowsahre
Bolt	Mailbox
Frame of Doorway	'Stake'
Grape Vine	Hardwood Post
Ironwood Flagpole	Iron Skillet
'Tamarack Stake Below Ventilator Hood	Fence Wire
Stone Over Rubbish	'Arrowhead Drilled in Stone'
A Sleigh Shoe	Broken Wagon Wheel
Bottle Cap	Boiler Grate
Stone Drum	Iron in a Cream Can
Cold Chisel	Whiskey Bottle
Draft Bolt	Fruit Jar
Old Lantern	Bedpost
'Three Teakettles in a Row'	Stake plus Brickbats
Grindstone	Hole in the Ground
File of Rocks	

Plus many, many more ...

CHAPTER III.

MONUMENT SELECTION
AND PURPOSE

Monument Selection and Purpose

I. Introduction

The survey monument and its accessories are the only permanent record the surveyors leave in the field. The monument is of high importance and takes priority over any written material when presented in a court of law. For this reason the surveyor should install the most permanent monument possible to reflect his work. By extensive research and with practical field knowledge various monument designs as well as different materials have been developed to meet varying soil and environmental conditions. Much time and energy have gone into making better written records, but even more emphasis should be given to making our monuments more permanent. Even in biblical times landmarks were considered of the highest importance. The National Society of Professional Surveyors recently published an interesting statement reflecting the importance placed on land marks and boundaries in Old Testament times (before Christ). A copy of this statement entitled "Land Ownership Landmarks and Property Lines" may be viewed on the following page of this report.



Land Ownership Landmarks & Property Lines

The privilege of Land Ownership is one of our most prized rights. Not all citizens of the world have the right to own their own land. It has been said that Land Ownership is the foundation of material wealth. Land like everything else, is a gift from God.

The Land of Canaan was divided among the twelve tribes by lot (Jos. 14:2). Landmarks such as marked stones were used as land division line markers for these lines and for other lines as early as 3000 B.C. Present day land markers take many different forms but mostly they are iron stakes with marked caps. In Deuteronomy 19:14, God gave implicit directions to the first planters of Canaan, to fix land marks according to the distribution of the land and forbid the mischievous removal of these markers, as such removal begets discord among neighbors, and thence come wars, and fightings, and endless disputes.

We as stewards of Gods Land must guard and protect our property lines and landmarks from destruction so that peaceful co-existence among neighbors and nations can be perpetuated.

"Proverbs 22:28 - Remove not the ancient landmarks which your fathers have set."

Distributed in promotion of Surveyors Week by the
National Society of Professional Surveyors

II. Monument Material Cost Comparison:

Pipe Type Monument Stock:

A. Dimensions:

Outside diameter of pipe - 2 3/8 inches

Wall thickness

Schedule 5 pipe - 0.065 inch

Schedule 10 pipe - 0.109 inch

Schedule 40 pipe - 0.154 inch

B. Prices: January 1987 Quotes

1. Stainless Steel Type 304

Schedule 5 pipe - \$3.19 per foot

Schedule 10 pipe - \$4.70 per foot

Quoted by Morris Steel Company, Denver, CO. Tel. 303/289-4401

2. Aluminum Type 6063-T6

Schedule 10 pipe - \$1.79 per foot

Schedule 40 pipe - \$2.30 per foot

Quoted by Kilsey Tube Supply, Denver, CO. Tel. 303/371-7600

3. Steel Pipe Type ASTM A-53 or ASTM A-120

Schedule 40 pipe - \$2.02 per foot

Quoted by Morris Steel Company, Denver, CO. Tel. 303/289-4401

Rod Type Monument Stock:

Prices: January 1987 (solid rod stock)

1. Stainless Steel Type 304

5/8" Outside diameter - \$2.08 per foot

Quoted by Morris Steel Company, Denver, CO. Tel. 303/289-4401

2. Aluminum Type 6063-T6

5/8" Outside diameter - \$.53 per foot

3/4" Outside diameter - \$.77 per foot

Quoted by Kilsey Tube Supply, Denver, CO. Tel. 303/371-7600

III. Monument Materials:

A. Regulation Iron Post:

The Bureau of Land Management has used the standard "galvanized steel pipe" monument for many years. This monument is fabricated from Schedule 40 material which gives it a wall thickness of 0.154 inch. This monument is a good monument and has been set in most every type of soil. The pipe body material is ASTM-A53 carbon steel. After the pipe has been cut and flared for the flange, it is hot dipped in a zinc ASTM (B-6) solution. This operation gives the pipe a galvanized surface protection both inside and outside the pipe.

The galvanizing process adds significant life to the carbon steel monuments. This has been proven in the BLM test beds near Salt Lake City, Utah.

The regulation monument is fitted with a brass cap, ASTM (B-30)5. The chemical composition is 81% copper, 9% zinc, 7% lead, and 3% tin.

Since the cap material is different from the pipe material, the top portion of the pipe is coated both inside and outside (a distance of 1 1/4") with an asphalt primer prior to riveting the cap onto the pipe.

In some cases the regulation iron post has been filled with concrete. This is a good practice. In some highly corrosive soils such as the

alkaline soils of Utah, the galvanized pipe may be corroded away after 70 years. The writer has observed some monuments in Utah where only the brass cap and concrete core were remaining. These particular monuments had been set in 1913.

Although the "Regulation Iron Post" is a very good product, other materials are presently available that provide better protection over a wider range of pH values.

B. Fiberglass Monuments:

Fiberglass and plastic monuments were introduced to the Bureau in the 1950's. Several of these monuments were set in Utah and sample monuments were also set in the test beds near Salt Lake City, Utah.

The fiberglass monument is made up of resins and coatings of fiberglass wrappings. The pipe dimensions are the same as those for the standard regulation monument, however, the flange at the bottom is different. Instead of a split base, the fiberglass monument has a large foot epoxed onto the pipe. The monument cap is made of brass and is identical to the cap used for the standard regulation monument.

The fiberglass monument is excellent in regards to corrosion resistant properties. Fiberglass test bed monuments have been inspected on a regular basis since 1967. In these corrosive type alkaline soils, the monument material below ground level continues to be in excellent (like new) condition.

For nineteen years this monument has had little or no change above the ground level. In the 20th year; however, the outer layer of resin has started to deteriorate and leave a frayed layer of fiberglass material. This condition is believed to have been caused by the sun's ultraviolet rays. It should be noted that the monument material above ground level is still solid and in good condition.

A primary drawback to the use of fiberglass is it's low melting point of less than 400°F. Another unknown is the effects of ultraviolet rays on this material over a prolonged period of 50-75 years.

Other nonmetallic materials have been examined by the Bureau and some of these materials are currently being evaluated in test beds, such as polyvinyl chloride (PVC) and carsonite. These materials are very similar to the fiberglass in that they have low melting points and the effects of long time ultraviolet exposure is unknown. As with fiberglass, the corrosion resistant properties of these materials are excellent.

C. Aluminum Monuments:

The aluminum monument has been used within the Bureau for several years. It has been used in both pipe and rod configuration and a sample pipe monument was placed in a test bed for observation in 1973. To date, this monument has encountered some pit type corrosion, but continues to be in good condition. This monument was set in an alkaline type soil of pH 8.5.

The aluminum pipe monuments are fabricated from schedule 10 stock which has a wall thickness of 0.109 inch. The rod monuments are fabricated from both 5/8 inch diameter and 3/4 inch diameter solid rod stock. The aluminum alloy that is used for all the monuments is A.A.6063 with a T-6 temper.

Aluminum has good corrosion resistant properties and protects itself by forming a surface oxide that prevents further chemical activity. Under certain conditions, however, this surface oxide may be removed and corrosion may result.

Some acids and alkalines will dissolve the protective oxide surface film and allow the base metal to corrode. For these reasons the cadastral surveyor should obtain as much information about the soil conditions as possible before he chooses a monument material.

Pure aluminum is highly resistant to chemical attacks (corrosion) and as alloying elements are added, the corrosion resistant properties decrease. Most aluminum alloys may increase there resistance properties by coating their outside surface with a layer of high purity aluminum. Another means that may be used to increase the corrosion resistance of aluminum alloys is an anodizing treatment. This process produces a very tough coating of aluminum oxide on the outer surface of the monument. An anodized monument has been placed in the Bureau's test bed and is presently being evaluated.

The aluminum pipe monument specification has recently been changed slightly. When the pipe was cut and flared for the foot flange, some monuments showed evidence of a cracking at the top of some saw cuts. In

some cases the metal was actually torn. To prevent this condition from recurring, stress relief holes are now required to be at the top of each saw cut.

The aluminum monument caps may be made from either Aluminum Alloy 535.0, QQ-A-601E, or Alloy 6063. The Aluminum Alloy 6063 is the same identical material as the pipe or rod body. Alloy 6063 has the following chemical composition:

Aluminum - 97-98%

Magnesium - 0.5 - 1.0%

Silicon - 0.25 - 0.50%

Other - Less than 1%

Alloy 535 has the following chemical composition:

Aluminum - 92-93%

Magnesium - 6.5-7.5%

Each aluminum monument cap must have a magnet permanently attached to the underside of the cap. The pipe monument cap must also be riveted to the pipe body with an aluminum rivet to insure compatible materials are used.

The aluminum monument is light in weight and easy to work with, but there are some disadvantages to using this material. Aluminum has a relatively low melting point. As temperature increase, aluminum loses its strength at 600°F and melts at approximately 1000°F. Although aluminum has good corrosion resistant properties it does not protect over as broad range of pH values as does stainless steel Type 304 or Type 316.

D. Stainless Steel Monuments:

Certain alloy combinations of iron and chromium are highly resistant to oxidation and corrosion. Sometimes other elements are added to these alloys such as nickel, silicon, molybdenum and tungsten to form a complex group of alloys known as stainless steels. There are many types of stainless steel and they come in a variety of price ranges.

A stainless steel monument has recently been adopted as an official BLM cadastral survey monument. Considerable time was given to choosing two acceptable materials that would have high corrosion resistant properties and yet be in an economical price range. The stainless steel materials that were chosen are S.S. Type 316 and S.S. Type 304. These two materials have a high percentage of both chromium and nickel and both have excellent corrosion resistant properties over a large range of pH values.

Alloying elements of S.S. Type 304 are as follows:

Carbon - 0.08% max

Manganese - 2.0%

Silicon - 1.0%

Chromium - 18.0 - 20.0%

Nickel - 8.0 - 12.0%

Alloying elements of S.S. Type 316 are as follows:

Carbon - 0.08% max

Manganese - 2.0%

Silicon - 1.0%

Chromium - 16.0 - 18.0%

Nickel - 10.0 - 14.0%

Either of these stainless steel alloys are acceptable for BLM monuments, and they have superior corrosion resistant properties to any other metals that BLM has used.

Both pipe and rod type stainless steel monuments are being used by BLM. The pipe monument has the same physical dimensions as the "Regulation Iron Post" with one exception. The pipe stock used has been schedule 5 which has a wall thickness of 0.065 inch. The regulation iron monument is fabricated from schedule 40 stock which has a wall thickness of 0.154 inch. The thinner material was chosen for two reasons:

1. To keep the monument price down
2. Because this material had superior corrosion resistant properties.

After reviewing the present stainless steel specifications, it was determined that a change was needed in the pipe material. The pipe stock is being changed to schedule 10 to give it a wall thickness of 0.109 inch. The specification change will increase the monument cost by

approximately \$3.75, but allows the wall thickness to be increased by 68%. This small increase in price will lengthen monument life significantly.

When pipe is cut and flared for the foot flange, some monuments have shown evidence of cracking at the top of some saw cuts. In some cases the metal was torn as was found with the aluminum monument. To prevent this problem from recurring stress relief holes are being placed at the top of each saw cut.

The stainless steel monument cap is identical to the regulation iron monument cap with one exception. The stainless steel cap requires that a magnet be permanently attached to the underside of the cap. The cap material, Brass Alloy ASTM (B-30)5, is relatively compatible with the stainless steel pipe body. Since the materials are dissimilar, however, the top of the pipe shall be coated both inside and outside with an asphalt primer for a distance of 1 1/4 inches. The cap is riveted to the pipe body with a stainless steel Type 304 or Type 316 rivet.

The stainless steel monument is an outstanding monument and the only disadvantage to using this product is that it costs more than the other BLM approved monuments. For long term durability, the stainless steel monument tops the list of BLM approved monuments.

CHAPTER IV.

MONUMENT ENVIRONMENT

Monument Environment

I. Introduction:

Cadastral survey monuments are subjected to many different environments. Since survey monument are set in the ground with about 6 to 8 inches left above ground level, they are subjected to both soil and atmospheric environments. Different monument materials may have chemical reactions with some of the various types of soil they are set in. Both galvanic and pitting type corrosion may result and have a devastating effect on certain materials. Soils having either a high or low pH value will significantly reduce monument life for many materials. The presence of water or high levels of soil moisture as well as temperature affects the rate of monument material deterioration. The presence of various types of salts also affects monument life.

Two other factors that will be discussed in this chapter are cold temperature (freeze-thaw) conditions and the ever present possibility of a fire (extremely high temperatures).

II. Soil:

Soil is sometimes a complex system being made up on gaseous, liquid and solid material. The solid material is made up of fragments of rocks and rock forming minerals, secondary minerals derived by weathering, dead organic matter, and living organisms. The liquid state of the soil is usually water

while the gaseous state is normally air. Soil chemistry may also undergo changes. Rocks of the soil are mainly made up from eight elements:

Oxygen	47% by weight
Silicon	28% by weight
Aluminum	8% by weight
Iron	5% by weight
Calcium	4% by weight
Sodium	3% by weight
Potassium	2.5% by weight
Magnesium	2% by weight

Chemical compounds of the soil interact in various processes and are usually one of the following types:

- a. Hydrogen is combined with an acid element to form acids.
- b. Oxygen is formed with other elements to form oxides. An example is the combining iron with oxygen to form iron oxide or rust.
- c. The hydroxyl radical (OH) combines with an element to form a base (alkali).
- d. The hydrogen of an acid is sometimes displaced by a metallic element and salts are formed.
- e. Acids and bases may combine to form salts and water.

Each one of these reactions may affect survey monuments in a different way.

Some key factors that govern the corrosivity of a given soil are as follows:

MATCHING MONUMENTS TO SOIL TYPES

1. pH (logarithm of the reciprocal of hydrogen ion concentration).
2. Electrical conductivity
3. Porosity (permeability)
4. Dissolved salts
5. Organic matter
6. Presence and hardness of water.
7. Temperature.

Of these factors the pH, conductivity, and temperature are the easiest to measure and are important parameters. The pH of a solution denotes its acidity or alkalinity. The neutral pH value is 7 with drinking water ranging from pH 6.5 to 8.5. Acids have values lower than 7 and the lower the pH number, the stronger the acid. Alkaline (basic) values are higher than pH-7 and the higher the number, the stronger the base.

Generally, low pH values indicate a more rapid rate of corrosion than do high pH values. Steel and cast iron are rapidly corroded by low pH waters. Galvanized steel is corroded by low pH fluids, but at a lower rate.

To help explain pH values further, see the pH Table below:

pH TABLE
RELATIONSHIP OF pH AND HYDROGEN ION CONCENTRATION

		Hydrogen concentration, gram mols per liter		
		pH		
Acid range	0	1.0	10^0	Strong Acid
	1	0.1	10^{-1}	
	2	0.01	10^{-2}	
	3	0.001	10^{-3}	
	4	0.000,1	10^{-4}	
	5	0.000,01	10^{-5}	
Neutral	6	0.000,001	10^{-6}	Weak Acid
	7	0.000,000,1	10^{-7}	
Alkaline Range	8	0.000,000,01	10^{-8}	Weak Base
	9	0.000,000,001	10^{-9}	
	10	0.000,000,000,1	10^{-10}	
	11	0.000,000,000,01	10^{-11}	
	12	0.000,000,000,001	10^{-12}	
	13	0.000,000,000,000,1	10^{-13}	
	14	0.000,000,000,000,01	10^{-14}	Strong Base

The symbol p comes from the German word "Potenz" (meaning power).

The symbol H refers to the Hydrogen Ion concentration.

III. Monument Materials:

Survey monuments may be corroded by either chemical or electrochemical means. Electrochemical or galvanic corrosion of a metal is due to an electrical contact with a more noble metal or nonmetallic conductor in a corrosive electrolyte (dissimilar metals submerged in water). Chemical or pitting corrosion attacks a metal in small areas and forms cavities or pits. Survey monuments are being destroyed by both galvanic and pitting type corrosion.

To give survey monuments maximum life, the surveyor must choose the proper material for the varying types of soil encountered. The following materials are being used by BLM cadastral:

ALUMINUM:

Aluminum has been chosen for monument material in some environments for the following reasons:

1. Good corrosion resistant qualities.
2. Low density (lightweight).
3. Relatively high strength.
4. Low cost.

Aluminum resists weathering and corrosion by forming a protective superficial film of oxide (Al_2O_3). This film forms and prevents corrosion from penetrating deeper into the metal. A thin film, almost invisible, is adequate to prevent further oxidation under most normal conditions. However, in the presence of chlorine, alkalies, certain acids and salt water, the film may be broken down and corrosion may result.

Most aluminum alloys that are heat treated are less resistant to corrosion than is pure aluminum or aluminum-manganese alloys. There are a few exceptions to this rule such as Aluminum Alloy 6053, which has increased corrosion resistant qualities in the quenched state.

There are some disadvantages to the use of aluminum and they are listed below:

1. The aluminum will not last well in salt environments or some acid soils.
2. Aluminum has a low melting point (approximately 1150°).
3. The aluminum should not be used in any soils containing copper.
4. When used in the rod form, monuments may bend easily.

The corrosion resistance properties of aluminum alloys may be improved by providing an anodizing treatment. This process produces a tough adherent coating of aluminum oxide at the surface of the material. Anodized aluminum monuments are presently being evaluated in the BLM alkaline test bed near Salt Lake City, Utah.

REGULATION GALVANIZED STEEL:

The galvanized steel (regulation pipe) monument has been used by BLM for many years and continues to be a good monument. The following statement was given on Page 247 of BLMs "Manual of Surveying Instructions" dated 1947.

"The Bureau of Land Management has adopted a standard iron post for monumenting the public-land surveys, which will be generally used unless exceptional circumstances warrant the

use of other material. This practice is deemed so important that no substitutions are permitted excepting as provided in Section 239, and if authorized, a statement will be given in the field notes."

The regulation galvanized steel monument was chosen to be BLMs standard for the following reasons:

1. High strength.
2. Good corrosion resistant qualities.
3. Years of experience with varying types of monument materials.
4. Reasonable cost.

The regulation standard pipe body, ASTM A-53 was found to resist corrosion better when galvanized by dipping the pipe into a hot zinc solution.

Although this monument continues to be a good product, there are some disadvantages to its use. The disadvantages are:

1. The monument does not protect over a large pH range. Both acid and alkaline soils corrode the monument.
2. The monument is not resistant to salt environments.
3. If the galvanizing coating is penetrated, the oxidation rate accelerates.

In a report (No. 76-5) published by Mr. Kenneth Jacobs, Department of Transportation, Augusta, Maine in 1976, interesting information was revealed relating to highway culvert life.

"Aluminum culverts are resisting corrosion better than zinc coated steel culverts for those installations where the pH is between 5.8 and 7.9 with resistivity readings above 8250 ohm cm."

STAINLESS STEEL:

There are many types of stainless steel; however, for survey applications and for economic reasons, only two types (Type 316 and Type 304) are recommended for use.

Stainless steel has been chosen for a monument material for the following reasons:

1. Excellent corrosion resistant qualities.
2. High strength.
3. Resistant to many acids including hot and cold nitric acid.
4. Provides corrosion protection over a wide pH range.

Stainless steels have the ability to form an oxide film, usually invisible, which acts as a constant protection against further corrosion on the underlying metal. In contrast to films on ordinary steels, the film is very stable, extremely tough and continuous, and is very adherent. If the film, chiefly

composed of chromium oxide is broken by scratching or chemical action, it reforms quickly and continues to protect.

Stainless steel Type 316 and Type 304, have excellent toughness at temperatures as low as liquid helium (-45°F) and are useful for severe stress applications at elevated temperatures.

There are some disadvantages to stainless steel:

1. More expensive than other monuments.
2. High density (heavier than aluminum monuments).

FIBERGLASS:

There may be areas where fiberglass monuments may be used. Some advantages for the use of fiberglass are as follows:

1. Excellent corrosion resistant qualities.
2. Light in weight.
3. Low cost.

Fiberglass would be chosen over PVC (Polyvinyl Chlorine). material for two reasons:

1. BLM has conducted a 20 year endurance test on fiberglass monuments and only has a 5-year endurance test on the PVC material.

2. If burned, the fiberglass monument will leave glass fibers for location identification.

Although the fiberglass monument has excellent corrosion resistant characteristics there are some drawbacks:

1. Low melting point.
2. Unknown ultraviolet affect over very long exposure to the sun.

The fiberglass monument should never be used in timbered areas or brush areas where a fire could destroy the monuments. This monument should be limited to areas having minimum or no vegetation.

The following recommendations are being made in regards to using the proper monument material in different types of soil:

RECOMMENDED MONUMENT TYPES
FOR
VARYING SOIL CONDITIONS

1. Strong Acid Soils

pH - 6 and below

- A. First Choice - Stainless Steel Type 316 or 304.
- B. Second Choice - Aluminum.
- C. Third Choice - Standard Galvanized Steel.

2. Strong Alkaline Soils

pH - 8 and above

- A. First Choice - Stainless Steel Type 316 or 304.
- B. Second Choice - Aluminum.
- C. Third Choice - Standard Galvanized Steel.

3. Normal Soils

pH - 6-8

- A. First Choice - Stainless Steel Type 316 or 304.
- B. Second Choice - Aluminum.
- C. Third Choice - Standard Galvanized Steel.

4. Soil Containing Salts

- A. First Choice - Stainless Steel Type 316 or 304.
- B. Second Choice - Aluminum.
- C. Third Choice - Standard Galvanized Steel.

5. Wooded or Timbered Areas

- A. First Choice - Stainless Steel.
- B. Second Choice - Standard Galvanized Steel.

Note: Aluminum monuments are not recommended due to low melting point temperature.

6. Heavy Brush and Grassland Areas

- A. First Choice - Stainless Steel.
- B. Second Choice - Standard Galvanized Steel.

Note: Aluminum monuments are not recommended due to low melting point temperature.

7. Minimum or No Vegetation

- A. First Choice - Stainless Steel.
- B. Second Choice - Fiberglass.
- C. Third Choice - Aluminum.
- D. Fourth Choice - Standard Galvanized Steel.

Examples of monument corrosion experienced in alkaline soils may be viewed on the following pages. Note how corrosion progression varies with different types of materials.

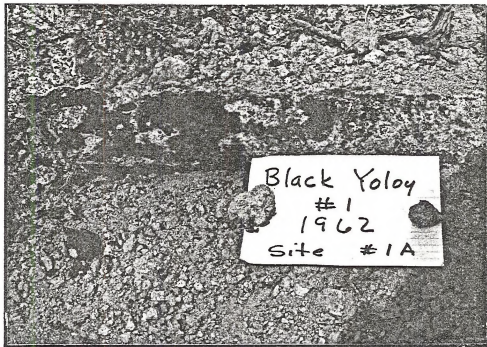
EXAMPLES OF CORROSION DAMAGE
TO
VARIOUS TYPES OF MONUMENTS

Black Yoloy

Monument Test Set - No. 2

Set in 1962

Inspection Date - June 23, 1983

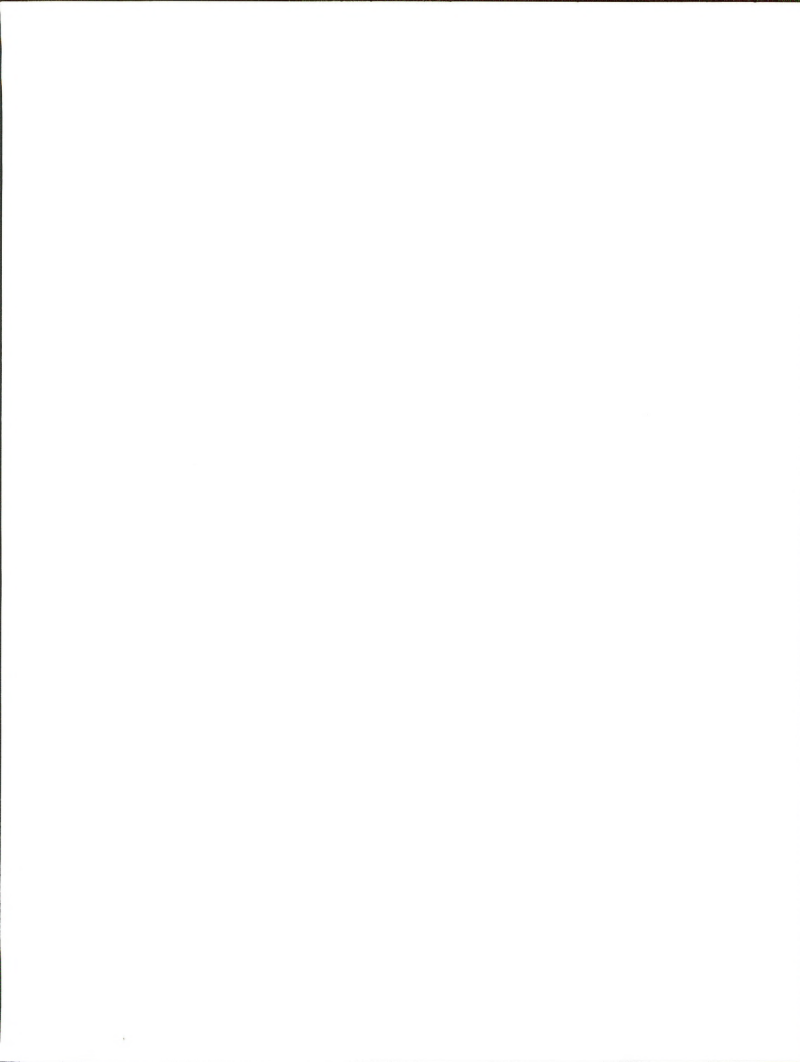


Above ground level there is a slight rust but this portion of the monument is very solid.

At the ground line there is a heavy rust build-up with pitting.

Below ground level there is a severe rust build-up with continuous pitting over the entire pipe body. The corrosion gets worse with depth. The flange and lower three to four inches of the pipe have corroded away. The corrosion is in the form of deep pits, appearing red-black in color.

This monument is in very poor condition, with large holes appearing in the lower portion of the remaining pipe.



Black Carbon

Monument Test Set - No. 2

Set in 1962

Inspection Date - June 23, 1983



Above ground level the monument is rusty but in good condition.

At the ground line the rust starts to build up and is associated with small pits.

Below ground line there is a heavy build-up of rust with severe corrosion. There are many large pits over the entire pipe body with several holes appearing in the lower portion of the pipe. The flange and lower four inches of the pipe have completely corroded away.

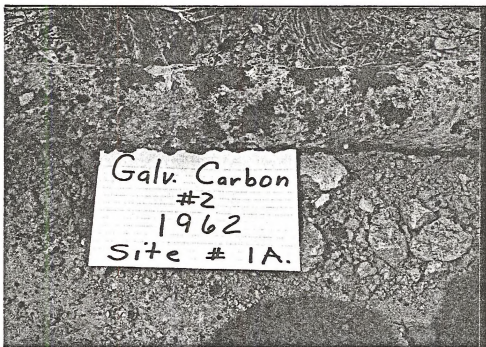
This monument is in very poor condition.

Galvanized Carbon

Monument Test Set - No. 2

Set in 1962

Inspection Date - June 23, 1983



Above ground level there is no rust and this portion of the monument is in very good condition.

A light rust begins at the ground line, and below ground there is a heavy build-up of rust with severe pitting. Some pits have corroded through the pipe wall. This corrosion is in the form of pits with no uniform pattern. Pitted areas are red-black in color.

This monument is in poor condition.

Aluminum Pipe

Monument Test Set - No. 2

Set in 1973

Inspection Date - June 23, 1983



Above ground level the monument is gray in color, slightly discolored, but in very good coondition.

At the ground line the monument has slight pitting.

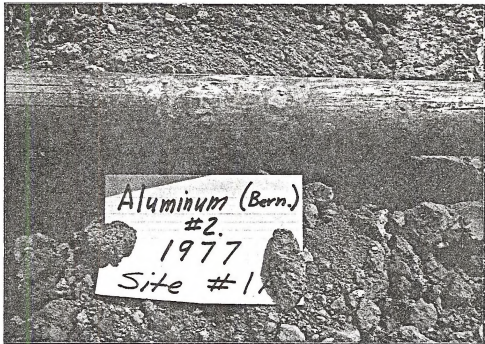
Below ground level the monument has some pits over much of the body. Some of the pits are deep, measuring approximately $1/16$ " deep. The foot pad has a few corrosion spots evidenced by a white crystalline type structure.

Aluminum Pipe

Monument Test Set - No. 2

Set in 1977

Inspection Date - June 23, 1983



Above ground level this monument has a few discolored spots, but is in excellent condition.

At the ground line there is a slight corrosion over large areas of the pipe.

Below ground level the monument has deeper pits but covering smaller areas than the corrosion at ground line. Some of these pits are approximately 1/16" deep. Many spots on the pipe body are covered by white crystalline particles.

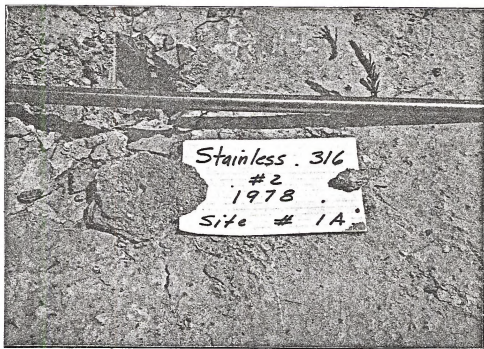
This monument is in good condition.

Stainless Steel, 5/8" Rod, Type 316

Monument Test Set - No. 2

Set in 1978

Inspection Date - June 23, 1983



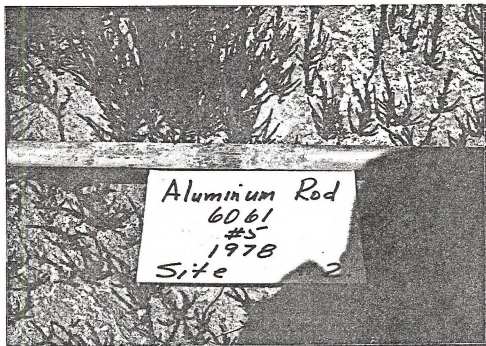
This monument is in excellent condition, both above and below ground level.
The metal is bright and looks as it did when it was installed.

Aluminum Rod, 5/8", Type 6061

Monument Test Set - No. 5

Set in 1978

Inspection Date - June 23, 1983



Above ground level the monument has a few dark spots, but it is in very good condition.

At the ground level there is severe pitting type corrosion covering the entire circumference of the rod. The pitted band width is approximately 1" wide and the depth of corrosion varies from approximately 1/32" to 1/16" deep.

Below ground level there appears to be corrosion at the drive point-rod interface. White crystalline particles are present in this area.

This monument is in good condition except for the area at the ground line.



IV. Water:

Generally speaking, the presence of water seems to accelerate the rate of monument corrosion. Monuments set in a wet marshy soil may exhibit a higher rate of galvanic corrosion than one set in the same soil composition but having a low soil moisture. This is not to say; however, that dry soils are not corrosive. Some dry type soils are very highly corrosive even though they may have a low soil moisture content.

In all cases it should be safe to say that salt water is more corrosive than fresh water.

The surveyor should give careful attention to the monument he chooses for soils containing high moisture.

V. Temperature:

Although elevated temperatures usually accelerate the rate of monument corrosion, the focus of this study is on temperature extremes. Very low temperatures may cause frost heaving of monuments as have been experienced in Alaska. Very high temperature which accompanies forest fires will destroy some monument materials.

Low temperature:

Problems have been encountered in cold climates when freezing and thawing occurs. In Alaska, some rod type monuments are being jacked from the ground due to the frost heave. In other areas of Alaska some pipe

monument have developed small lakes of water around them. In other areas pipe monument have submerged below the ground surface. These are all ongoing problems that are being studied at the present time. Hopefully these type problems will be helped by field research that is being planned.

B. High Temperature:

Surveyors should also consider the possibility of a fire when choosing a monument material. Many new products have been introduced that resistance corrosion such as fiberglass, PVC, and carsonite, but these three products have very low melting points. In the event of a fire, monuments made from these materials would be lost. The best plastics that can be purchased today will melt at less than 400°F. Even aluminum will lose all it's strength at 600°F and start to melt at 1000°F. So these factors should also be considered when choosing monuments.

Steel and stainless steels will withstand high temperatures (2700°F). They are always good choices where fire is a consideration, such as grass lands or forest lands. (See attached photographs of monument damage due to fire.)

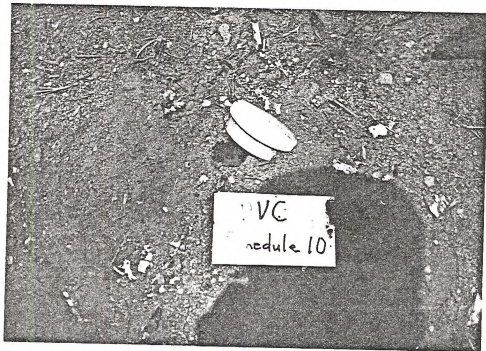
EXAMPLES OF FIRE DAMAGE
TO
VARIOUS TYPES OF MONUMENTS

No. 2 - Polyvinyl Chloride, PVC, Yellow (SE), Schedule 10

Burn Site No. 2

Set June 9, 1982

Inspection Date - June 16, 1983



There was no evidence of this pipe above ground level. The pipe had melted in the heat and there was no evidence of the material above ground level. Below ground level the pipe was found to be in excellent condition.

The cast aluminum-magnesium alloy cap had an irregular surface with ripples indicating that a near melt condition had been reached in the heat.



No. 3 - Polyvinyl Chloride, PVC, White (SE), Schedule 80

Burn Site No. 2

Set June 9, 1982

Inspection Date - June 16, 1983



There was no evidence of this pipe above ground level. The pipe had melted in the heat and there was no evidence of the material above ground level. Below ground level the pipe was found to be in excellent condition.

The cast aluminum-magnesium alloy cap has completely melted.

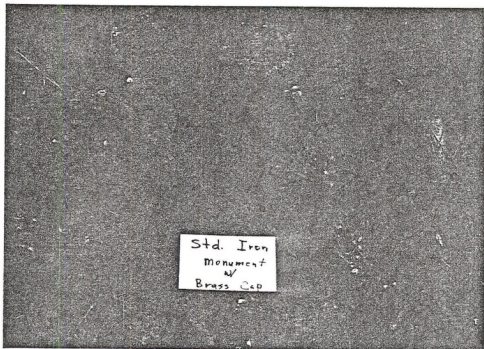


No. 4 - Galvanized Iron Post (Standard Monument)

Burn Site No. 2

Set June 9, 1982

Inspection Date - June 16, 1983



This monument came through the fire in very good condition. The pipe was not damaged and the galvanizing appeared to be in very good condition.

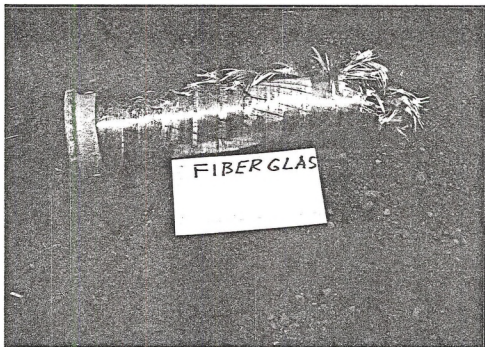
The brass cap was not damaged by the fire. The cap was in excellent condition.

No. 5 - Fiberglass, Schedule 10

Burn Site No. 2

Set June 9, 1982

Inspection Date - June 16, 1983



This monument was severely damaged in the fire. All resin had melted away and the monument had broken at ground level. Only frayed glass fibers remained of the pipe above ground. Below ground level the pipe was in very good condition.

The cast aluminum-magnesium alloy cap showed evidence of melting on the outer edges. The top of the cap had a checked pattern indicating that the metal had been very near a liquid state.

No. 6 - Anodized Aluminum Post

Burn Site No. 2

Set June 9, 1982

Inspection Date - June 16, 1983



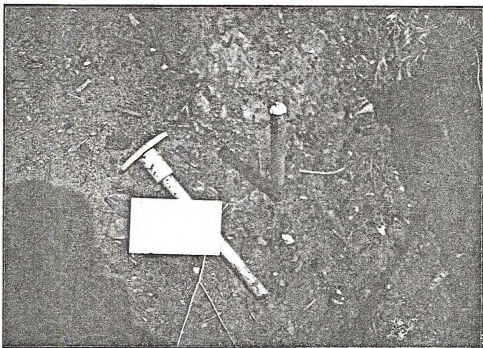
Both the pipe body and cap of this monument came through the fire in very good condition. It should be noted that this cap was a forged aluminum cap.

No. 7 - Aluminum Rod, 3/4", 6063-T6

Burn Site No. 2

Set June 9, 1982

Inspection Date - June 16, 1983



The rod section of this monument had cracks and raised portions, indicating a near liquid state. At about 18 inches above ground level the rod had broken and the top portion of the rod and cap had fallen to the ground. The forged aluminum cap was in good condition.

No. 8 - Carsonite Rod, 5/8"

Burn Site No. 2

Set June 9, 1982

Inspection Date - June 16, 1983



This monument was severely damaged in the fire. All resin had melted away and the rod had broken at ground level. Only frayed glass fibers remained above ground level. Below ground level, the rod was in very good condition.

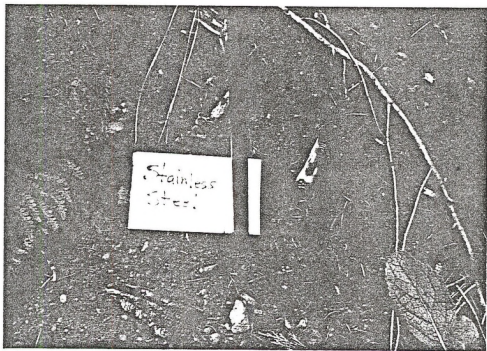
The cast aluminum-magnesium alloy cap had melted. The cap magnet could be seen and was in very good condition.

No. 9 - Stainless Steel Rod, 5/8", Type 304

Burn Site No. 2

Set June 9, 1982

Inspection Date - June 16, 1983



The stainless steel monument was not damaged by the fire. This rod was found to be in very good condition.

A cap had not been placed on this monument when it was set on June 9, 1982.

COMMENTS CONCERNING THE BURN

According to Mr. Bill Rametes, National Forest Service, Redding District, this prescribed burn was a normal type slash fire. The fuel in this burn area was a mixed conifer logging slash with very little grass or brush. Although temperature measurements were not taken, the fire most likely did not have a uniform temperature. It is believed that some areas of the fire burned at a higher temperature than other areas. So conclusions drawn from this inspection should be tempered with the above knowledge. It should be pointed out, however, that all monuments were set relatively close to each other in one area (approximately 20' x 10'), and the fuel loading in this area was fairly uniform.

The fact is that some aluminum monuments melted while others did not. Forest Service representatives felt that hot spots in the fire may account for this condition. Another fact is that both aluminum pipes survived the fire while the aluminum rod did not. Examining this condition more closely, the pipes have a much larger surface area than the rod has. Since aluminum is an excellent conductor, it could have conducted some of the heat from the hot side of the pipe, leading edge of the fire, to the cooled side, and also conducted heat to the ground and kept the temperature from rising above the melting point for aluminum, approximately 1080° F. The surface area in contact with the ground is much larger for the pipes also.

Another observation made from this inspection was that the cast aluminum-magnesium alloy caps melted more readily than the pure aluminum caps. This could be accounted for by having different temperatures within the fire.

The carsonite, fiberglass, and PVC monuments were either severely damaged or destroyed and are not recommended for use in this type of environment.

The standard iron post type monument and the stainless steel rod were not damaged by the fire.

VI. Monument Installation:

A. Pipe Monuments:

A hole is first dug and the earth material is evacuated. Although it is not a requirement, it is considered good practice to place a magnet in the bottom of the hole beneath the monument. If a monument corrodes away or is removed, the magnet may allow the point to be reestablished without a resurvey. The pipe monument, post, is set into the hole, approximately three-fourths of its length. Sand and/or stones or rocks, if available, are next tamped into the evacuation. Tamping should be continued until the monument has a solid anchor.

The monument cap should be marked with steel dies with the appropriate data. For example:

	T 23 N	
R 17 E		R 18 E
S 36		S 31
S 1		S 6
	T 22 N	

1987

Pipe type monuments should always be set at a depth of three-fourths of their length, unless hard rock or other materials prevent a complete evacuation. In these cases the monument must be set as deep as possible. Stones should be piled around the monument and tamped until one-fourth of the pipe is above the stones. Insure that the stones are positioned so that the monument has a solid firm anchor.

When monuments are set in wind-blown soils or on hill slopes, a special installation procedure is recommended. After the monument has been set and backfilled by tamping, the monument should be surrounded by a mound of stones. The base of stones should be about three feet in diameter. In this case the stones should be piled around the monument until only the cap shows above the mound. Larger stones should be used on the outer circumference and smaller stones used in close to the monument cap. See Figure 1.

B. Tablet Monuments:

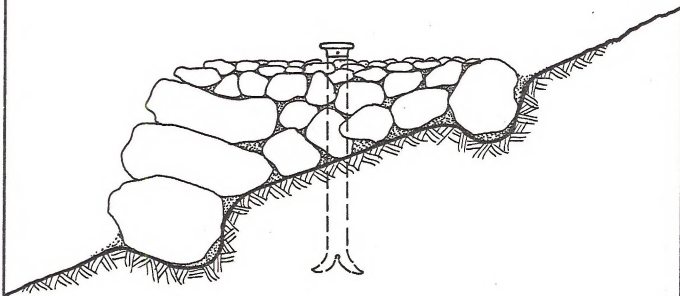
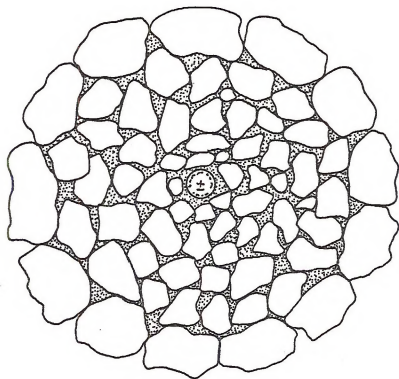
The tablet monument is often used in mountainous areas where a corner falls on a rock outcrop or on slopes where a standard pipe monument would be impractical. In these cases a hole is drilled into the rock slightly larger than the tablet stem. A recess is made for the top. A cement mixture is made and used to cement the tablet monument into position and seal it against moisture. Suggested concrete ratio is: Use one part cement, two parts sand, and three parts coarse sand or fine gravel.

The tablet monument is marked with steel dies the same as the standard pipe monument.

C. Rod Monuments:

General:

Rod type monuments are sometimes used by the Bureau of Land Management (BLM). Rod monuments are used in soft soils and marsh areas where the



A mound of stone used on loose wind blown soils or on slopes.
(Base should not be less than 3 feet in diameter)

standard pipe monument has insufficient length to provide a stable position. In some areas of Alaska, for example, rod monuments have been driven to depths of thirty feet or more before a resistance level (point of refusal) has been reached.

Rod type monuments are driven into position as opposed to digging a hole for installing the standard pipe type monument. BLM uses two regulation sizes of rod monuments:

- A. 5/8" diameter rods
- B. 3/4" diameter rods

Either power or manual tools may be used to drive the rod type monuments.

Attach the point:

- A. Examine the point carefully to ensure that the inside threaded area is clean.

NOTE: Ensure that the proper sized point is being used with the proper sized rod. Rods, points, floating threads, and caps are available in two different sizes, 5/8" diameter and 3/4" diameter. Do not interchange 5/8" hardware with 3/4" hardware.

- B. Remove both plastic end caps from the first rod section. A floating thread will be protruding from one end of the rod.

- C. Screw the point onto the floating thread and tighten finger tight.

The point should go on smoothly and easily.

- D. Using one small pipe wrench as a backup, tighten the point onto the rod section with a second wrench. Use wrenches no larger than 10" size.

Drive rod/rods into position:

After the point has been securely attached to the first rod section, place the spiral pointed end of the rod on the ground where it is to be driven.

- A. Install a new floating thread section at the top of the rod. Tighten the floating thread finger tight.

NOTE: Exercise care when installing floating threads to ensure they are not cross threaded.

- B. Place drive head adapter over top of rod where the floating thread has been installed.

NOTE: Ensure that the proper sized drive head adapter is used.

- C. Drive the rod into the ground. Either manual or power tools may be used for this operation.

- D. When the bottom of the drive head adapter is about three inches above the ground, stop driving and remove the drive head adapter from the rod.
- E. Inspect the drive head adapter to ensure it is clean and undamaged. Once a day, apply a light coating of oil onto the inside surface of the drive head adapter.

Add additional rods:

- A. Remove the end caps from the next rod to be driven. Screw the new rod section onto the exposed floating thread of the rod already in the ground.
- B. Using one pipe wrench as a backup, tighten the new rod section onto the driven rod with a second pipe wrench.
- C. Verify the spiral point is tight by trying to rotate the top rod clockwise with a small pipe wrench.

NOTE: In sandy or loose soils, the rod will rotate with slight resistance. As greater depths are reached, more force will be required to rotate the string. When rods have been driven to refusal, the operator may not be able to rotate the rod string.

NOTE: When driving a rod string, the operator must check for tightness after driving each rod. This will ensure that the entire rod string is tight and properly installed.

- D. The new rod will have a floating thread section exposed at the top of the rod. Ensure the floating thread has been tightened finger tight.
- E. Place drive head adapter over top of new rod and exposed floating thread.
- F. Drive the new rod section into the ground in the same manner as above.
- G. When the bottom of the drive head adapter is about three inches above the ground, stop driving and remove the drive adapter from the rod.
- H. Inspect the drive head adapter to ensure it is clean and undamaged.
- I. Repeat steps A through H until the desired depth is reached.

Install the cap:

- A. After the desired depth has been reached, remove the floating thread from the top rod section.
- B. If the point of refusal has been reached and the top rod section is too high, cut off the rod to give proper height using a hacksaw.
- C. Scribe a mark one inch below the top of the rod using a pencil or nail. This mark is to show the operator when the cap has been properly seated on the rod.

- D. Place the monument cap over the top of the rod. Place a block of wood or leather on top of the cap to protect the markings. Now tap the cap firmly onto the rod until the bottom of the cap meets or slightly exceeds the one-inch scribe mark on the rod.
- E. The monument is now completely installed and no additional bonding or crimping is necessary.

NOTE: Either manual or powered impact hammers may be used:

Good manual choices are:

- 1. Bronze sledge hammer
- 2. Urethane-faced shot-loaded hammer

Maintenance:

- A. The drive head adapters are in two sizes:
 - 1. For 3/4" rods
 - 2. For 5/8" rods
- B. Always use the properly sized drive head adapter for the rods being driven.
- C. Verify that the inside bores of the drive head adapter are clean. The large hole is for the rod and the small hole is for the floating thread to fit into.

- D. At the end of each day, lightly lubricate the inside of the drive head adapter with light oil.
- E. Inspect the drive head adapter frequently to ensure it is free from chipping and mushrooming.
- F. If mushrooming or chipping occurs, switch to an undamaged drive head adapter. The damaged adapter may be dressed by grinding off the affected area, as with any other tools.

Caution:

Mushroomed or chipped drive head adapters may become a hazard as well as drive head adapters constructed from cold rolled steel. Either condition may result in metal particles flying off and could result in eye injury. The user should wear safety glasses.

CHAPTER V.

AREA MAPS



Area Maps

I. Introduction

For many years BLM used only one standard monument, "The Regulation Iron Post". This monument was set in all types of soil such as acid, alkaline, salts, water saturated, frost-heave areas, and others. Metallurgical studies have shown that other materials such as stainless steel, aluminum, fiberglass, etc., may resist corrosion in certain types of soil better than the Regulation Iron Post. It is felt that matching a proper material to each varying soil condition would prolong monument life significantly.

Independent research and study have shown us which material is best suited for each type of soil, but many times the field surveyor does not know what type of soil is in his area. To help the surveyor match the best monument material to his soil conditions, he will need a soils map covering the area of concern.

II. Soil Properties

Soil scientists have collected data on many areas of each state. Thousands of test holes have been bored where soil samples have been taken for laboratory analyses. Most of these studies have been slanted toward agricultural uses, however, some of this information may be helpful to the surveyor. The field surveyor is interested in the chemical properties of the soil and how they relate to corrosion, frost-heave conditions, etc. The cadastral surveyor wants to install the most permanent monument (that is practical) to show as field evidence of his work.

A. Physical Properties:

The texture of a soil is described according to the percentages of clay, sand, and silt present. "Loam" is soil that has the following consistency:

1. Clay - 7 to 27%
2. Silt - 28 to 50%
3. Sand - Less than 52%

If a soil has a higher percentage of sand it may be called "sandy loam" where a soil containing gravel may be called "gravelly loam".

The texture of the soil is important to a surveyor because this characteristic will affect the permability and porosity. Soils that hold moisture and are not well drained may result in a higher rate of monument corrosion. Important characteristics that influence soil water capacity are as follows:

1. Soil texture
2. Soil structure
3. Organic matter present

Frost heaving is another problem surveyors encounter. Again both the soil texture and water holding capability affects the extent of frost heave. Frost action results from soil moisture freezing and causing ice to form. Factors that affect frost heaving are as follows:

1. Moisture content present
2. Soil texture
3. Porosity
4. Permability
5. Temperature
6. Organic matter present

In general, well drained gravelly or sandy soils are least susceptible to frost action, while clayey soils are most effected.

B. Chemical Properties:

Some soils induce chemical reactions with monument materials and weaken or even dissolves the monument over a period of time. The pH range of a soil will greatly affect the corrosion rate of monuments as has been described in the "Monument Environments Chapter" of this report. Both low pH values (acids) and high pH values (alkaline)) have a detrimental effect on monument materials.

The salinity of a soil, sometimes expressed in terms of electrical conductivity, will also increase the corrosion rate for most metals as well as concrete. Increased salinity within a soil also makes the soil less suitable for growing vegetation. If the salinity becomes high enough, plant life may not be maintained.

III. Maps

In order to make the proper monument material choices, the field surveyor needs to have soil maps for each area being surveyed. As a first step, the surveyor should contact a BLM soil scientist in his State Office or his field office if one is available. Inform the soil scientist of the type information that is needed such as:

- A. pH values
- B. Salinity
- C. Soil texture
- D. Soil moisture

If BLM soil scientists cannot provide the type information that is needed, the surveyor should contact the U.S. Department of Agriculture, "Soil Conservation Service". This agency has many small offices in rural areas with soil maps that may be examined.

CHAPTER VI.

COOPERATION WITH STATE AND
COUNTY GOVERNMENTS



THE INFORMATION IN THIS CHAPTER WILL BE SUPPLIED
BY THE WASHINGTON OFFICE

CHAPTER VII.

MONUMENT SEARCH, EVALUATION
AND REPLACEMENT

THE INFORMATION IN THIS CHAPTER WILL BE SUPPLIED
BY THE WASHINGTON OFFICE



CHAPTER VIII.

MONUMENT SPECIFICATIONS

Monument Specifications

I. Introduction

For many years BLM used one type of monument. The official monument was the regulation iron post. This was a very good monument and it continues to be used today. In some cases the regulation iron post was concrete filled, but generally it was not. For a short time a copper coated steel rod (copperweld) type monument was used, but it was discontinued several years ago.

With the passing of time it became apparent that the regulation iron post was corroding away very quickly in some types of soil. For this reason BLM Cadastral Survey began a program to investigate new materials in an attempt to find a monument that would corrode at a slower rate. As a result of these studies coupled with test bed evaluations, several new materials have been adopted. Both aluminum alloys and stainless steel alloys are currently being used.

Cadastral survey monument specifications have recently been revised. Considerable time was devoted to choosing corrosion resistant materials as well as to the design of each type monument. Careful consideration was given to each monument's physical dimensions, and all measurements for pipe, rod, and cap are critical.

When BLM survey monuments are procured they must meet BLM high quality standards.

A complete list of BLM approved monuments may be observed on the following pages of this report.

CADASTRAL SURVEY MONUMENT SPECIFICATIONS





U.S. Department of the Interior
Bureau of Land Management
Cadastral Survey
Washington, D.C.

Regulation Iron (Steel) Pipe Monument, Specification No. 9691.41

1. General: See Drawings

This specification refers to the Regulation Iron (Steel) Pipe Monument as found in Chapter IV-7 of the Manual of Instructions for the Survey of the Public Lands of the United States - 1973, Department of the Interior Technical Bulletin No. 6, referred to as The Manual. This specification was developed over the 70 plus years since the stone cadastral survey monument/iron pipe-brass cap monument was identified to replace wood and pit. The monument weights about 12 pounds.

2. Monument Cap:

The monument cap will be Brass, Alloy 5A, conforming to ASTM (B-30)5 or equivalent. Alloy 5A has the following chemical composition: 81% copper; 3% tin; 7% lead; and 9% zinc.

Cap dimensions are shown on the drawing (see Drawing No. 2). The surface shall be smooth and have medium gloss, polish-like finish. The cap shall have a socket portion which is specially shaped to force fit over the outside diameter of the pipe's upper end. The cap is held in place on the pipe by a solid stainless steel rivet.

The standard Cadastral Survey inscription will be cast into the cap, as specified in the drawing (see Drawing No. 1). All letters and numbers shall have clean, unbroken lines, and be clear and legible. A sample cap showing the quality of inscription and degree of polish acceptable under terms of this contract is available for inspection at the Bureau of Land Management, Denver Service Center, Building 50, Denver Federal Center, Denver, CO, 80225.

3. Cap Rivet:

The cap rivet will be a 3/16" x 3" Flat or Oval Head Rivet, solid Stainless Steel, Type 304 or equivalent.

4a. Monument Pipe:

The monument pipe is made from Class A, standard weight Schedule 40, continuous weld, steel pipe about 2-3/8" outside diameter, and is cut 30" long (+ 3/8"). The Pipe Specifications for the steel pipe shall meet or exceed ASTM A-53, ASTM A-120 (or latest revision).

Regulation Iron (Steel) Pipe Monument, Specification No. 9691.414b. Pipe Base:

The pipe base is shipped flared (pipe cannot be flared in the field) to a minimum width of approximately 4-1/2" (see Drawing No. 3). The flange spread shall be accomplished in such a manner as to prevent any cracking at the point of separation. If deemed necessary this may be accomplished by drilling stress relief holes approximately 3/8" in diameter prior to bending pipe. Splitting may be accomplished by either hot or cold methods. This style of monument allows the placement of additional sub-surface detection devices, such as magnetic markers, which would remain intact at the original point of survey in the event the monument is vandalized or pulled from the ground.

4c. Sub-surface magnet:

The sub-surface magnet that may be required for use with this monument shall be a ceramic magnet housed within a plastic container. The container shall be marked or color coded in a manner to indicate how the magnet should be placed. The magnet shall have a field strength of 550 (+10) gammas* and a detection range up to 8 feet. Detection range is based on the use of a model GA-52B locator or equivalent. Recommended magnet dimensions are shown on the drawing (see Drawing No. 3).

*Note: One gamma = 1/100,000 gauss

4d. Galvanization:

After flanging and other machining, the pipe shall be completely coated with zinc inside and outside by hot-dip process. Procedure shall comply with MIL-Z-17871A, or latest revision. Zinc used shall comply with ASTM (B-6) 5, 7. The weight of zinc coating shall not be less than 2 ounces per square foot of coated surface, determined in Section 12 of ASTM A72-59.

5. Assembly:

The pipe mating surfaces (zinc coated outside pipe surface, and inside surface of cap skirt) shall be coated for a distance of approximately 1-1/4" from end with fluid asphalt primer, conforming to Federal Specification SSA-701, prior to assembly. The monument cap shall be pressed onto the top of the pipe with a firm fit and shall bottom inside the cap. The cap and pipe shall be drilled and fitted with a rivet prior to shipment. A matched through hole shall be drilled for the rivet by using a guided "V" block to assure the hole is drilled on the pipe center line. Sufficient edge material must be allowed to prevent the rivet hole from cracking out when the rivet is set.

Regulation Iron (Steel) Pipe Monument, Specification No. 9691.41

6. Bundling for Shipment:

Pipe monuments shall be banded in units of 3 per bundle (see Drawing No. 3). The bundle shall be strapped with at least 2 bands of heat-sealed plastic strapping. The banding process shall keep the monuments in a side-by-side relation within each unit.

A pallet will consist of 30 bundles of 3 monuments each, totalling 90 monuments per skid; weight per skid shall be approximately 1080 pounds. Pallets shall be banded with at least 4 bands (2 bands N-S, and 2 bands E-W) of heat-sealed plastic strapping.

7. Marking for Shipment:

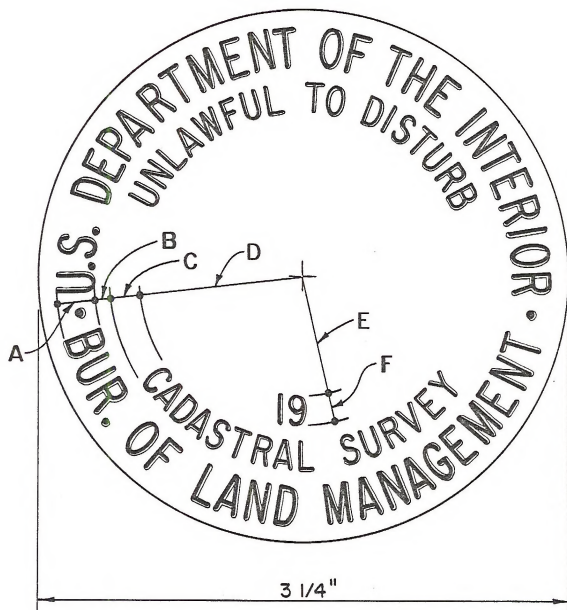
Each bundle of 3 survey monuments shall have a sturdy tag securely attached to the outside in a prominent location. The tag shall contain the following information:

Address and destination; contract number; item nomenclature; contractor's name and date of shipment; total quantity each in the shipment; and gross weight.



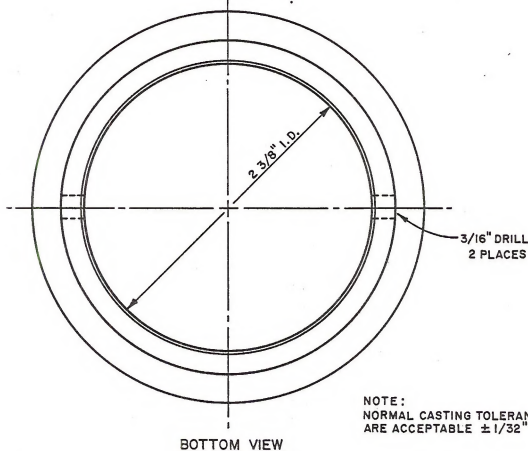
REGULATION IRON (STEEL) PIPE MONUMENT

Specification No. 9691.41

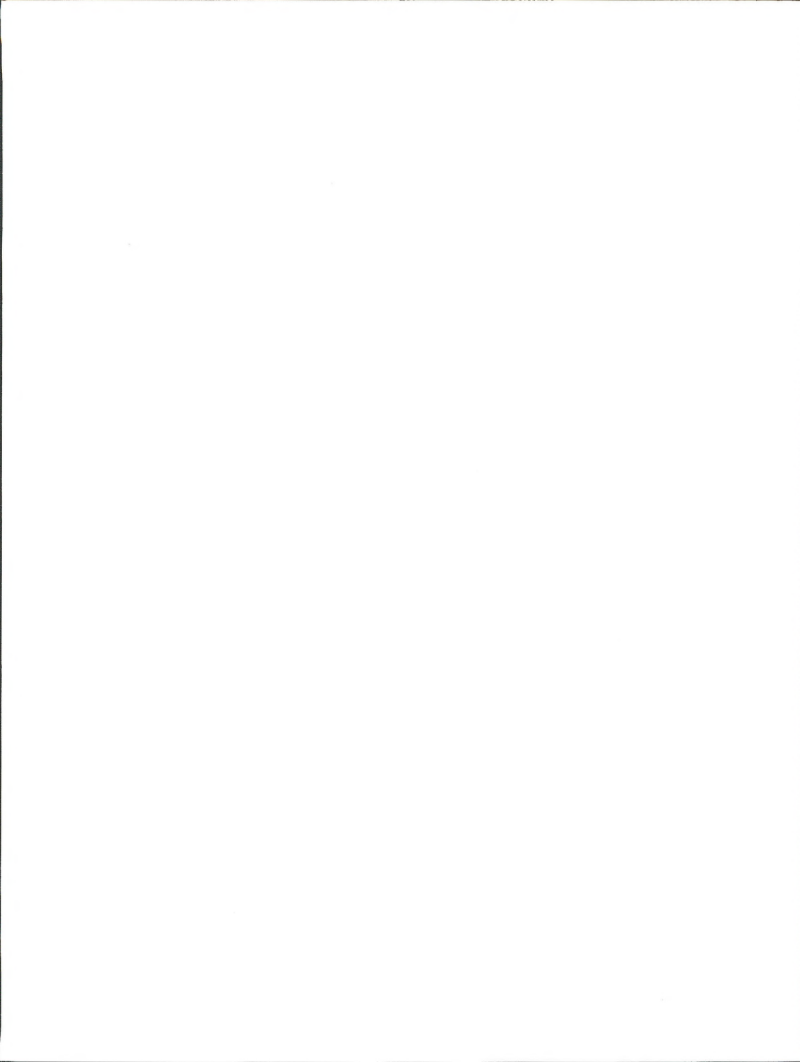


A	B	C	D	E	F
$\frac{1}{4}"$	$\frac{1}{16}"$	$\frac{3}{16}"$	$1"$	$\frac{11}{16}"$	$\frac{3}{16}"$

Specification No. 9691.41

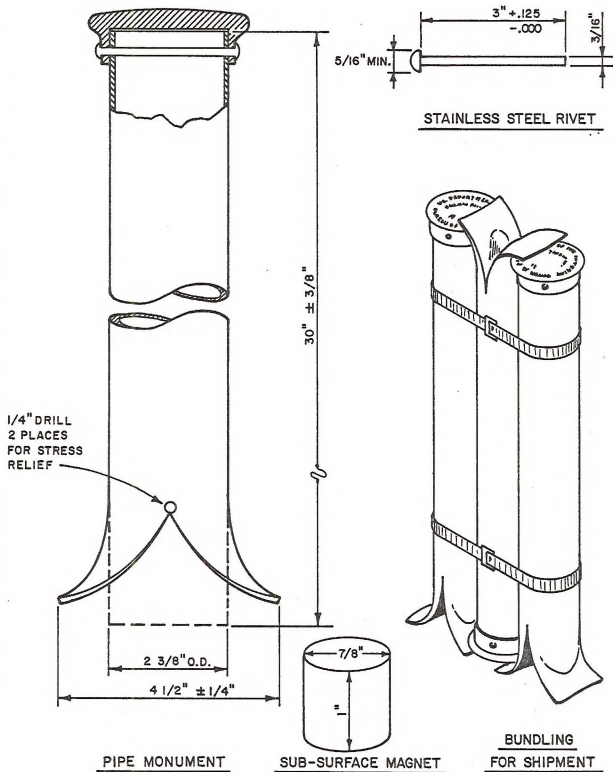


NOTE:
NORMAL CASTING TOLERANCES
ARE ACCEPTABLE $\pm 1/32"$



REGULATION IRON (STEEL) PIPE MONUMENT

Specification No. 9691.41





U.S. Department of the Interior
Bureau of Land Management
Cadastral Survey
Washington, D.C.

Regulation Aluminum Driven-Type Rotating 3/4" Rod Monument,
Specification No. 9691.42

1. General: See Drawing

The aluminum rod monument is often used in wet marshy areas where pipe monuments can not reach firm soil. The rod monument is also used in loose soils where pipe monuments may be frost-heaved. It is also light and convenient to use where packing-in or other logistics requirements may demand. This monument is assembled in the field, the aluminum cap being driven onto the last rod section. A complete monument consists of a point section, a threaded connector screw, a rod section, and an aluminum cap (with magnet), and weights about one-half pound. Rod sections and connectors may be added to increase the length of the monument so that the driven monument ultimately reaches a point of refusal.

2. Rod Monument Cap:

Monument cap alloy will be ALMAG 35. Alloy 535.0; QQ-A-601E's; or latest revisions.

Composition: Aluminum - 92-93%; Magnesium - 6.5-7.5%

Strength: Yield - 19,000-21,000 psi; Tensile - 38,000-44,000 psi;

Elongation - 10-15% (in two inches).

Cap dimensions are shown on the drawing (see Drawing No. 2). The surface shall be smooth and have a medium gloss, polished-like finish. The caps shall have a socket portion which has a slightly tapered, longitudinally fluted inside surface, specially shaped and adapted to fit over the uppermost rod section end. This socket configuration effectively prevents air pockets and provides an easy fitting, yet tight compression connection when the cap is tapped onto the rod section.

The standard Cadastral Survey inscription shall be cast into the caps as specified in the drawing (see Drawing No. 1). All letters and numbers shall have clean, unbroken lines, and be clear and legible. A sample cap showing the quality of inscription and degree of polish acceptable under terms of this contract is available for inspection at the Bureau of Land Management, Denver Service Center, Building 50, Denver Federal Center, Denver, CO, 80225.

A forged monument cap is also acceptable and is described as follows:

Cap material will be the same material as the rod section material (Alloy 6063) and a temper of T5 will be acceptable.

Composition: Aluminum - 97-98%; Magnesium - 0.5-1%

Silicon - 0.25-0.50%; Other - less than 1%

Regulation Aluminum Driven-Type Rotating 3/4" Rod Monument.
Specification No. 9691.42

Cap dimensions are the same as those for the cast cap above and are shown on Drawing No. 2.

The standard Cadastral Survey inscription shall be formed into the caps as shown on Drawing No. 1. All letters and numbers shall have clean, unbroken lines, and be clear and legible.

2b. Monument Cap Magnet:

The monument cap shall have a ceramic magnet permanently attached by either epoxy, mechanical fastener or both within the rod socket. The magnet shall have a field strength of 50 ($\pm$ 5) gammas* and a detection range up to 3.5 feet. Detection range is based on the use of a model GA-52B locator or equivalent. Recommended magnet dimensions and mounting is shown on the drawings (see Drawing No. 2 and 3).

*one gamma = 1/100,000 gauss.

3. Rod Section:

Rod sections shall be Alloy and Temper 6063-T6 solid extruded rod; QQ-A-200/9; SAE 4156; ASM 4156:ASTM B221; ANSI H38.5; or latest revisions.

Composition: Aluminum - 97-98%; Magnesium - 05.-1%;
 Silicon - 0.25-0.50%; Other - less than 1%;

Strength: Yield - 25.0-31.0 kpsi; Tensile - 30.0-36.0 kpsi;
 Elongation - 12% (in two inches).

Rod sections shall be 3/4" in diameter ($\pm$ 0.010") x 36" long. Both ends of each rod section shall be machine faced perpendicular to the rod centerline, and shall be drilled and tapped to a depth of 7/8" on the centerline, for a 7/16" x 14NC x RH thread. A "scratch" mark (grooved ring) shall be machined 1" from each end of the rod. A threaded connector screw shall be installed in one end of each rod prior to shipment.

4. Threaded Connectors:

Threaded connector screws, or floating connectors, shall be Type 347 Stainless Steel, in order to minimize galvanic action.

Threaded connectors shall measure 7/16" x 1-1/2" long, having 14 threads per inch RH. The threaded connectors shall be installed in the rod sections for shipping (except for spares), and capped with plastic caps.

Regulation Aluminum Driven-Type Rotating 3/4" Rod Monument,
Specification No. 9691.42

5. Plastic End Caps:

Rod sections shall be capped with large and small protective plastic end caps of sufficient length to protect rod ends and threaded connector screw. See drawing for dimensioning details. The large end cap is to be placed on the end having the threaded connector.

End caps shall be manufactured from low density polyethelene, conforming to Federal Specification L-P390 or equivalent.

6. Point:

Point alloy may be ALMAG 35, identical material to, and specified under "2. Rod Monument Caps" or Aluminum Alloy 6063-T6.

The base end of the point shall be machine faced perpendicular to the point centerline, and shall be drilled and tapped to a depth of 7/8" on the centerline, to accept a 7/16" x 14NC x RH thread. The rod point may vary in design. The point shall be designed so that it will tighten the rod string as it is driven into the ground and provide resistance if a rod is pulled on. New point designs (that have not previously been used) shall be approved prior to production. Points may be shipped to Bureau of Land Management, Denver Service Center, Building 50, Denver Federal Center, Denver, Colorado 80225, for approval.

7. Packaging:

Standard packaging "A-bundle" will include:

- a. 5 each, Boxes of 36 inch rod sections. Each box will contain 20 rods with a connector screw installed in one end of each rod, and shall be protected by plastic caps on each rod end.
- b. 1 each, Box of points
1 each, Box of caps
1 each, Box of threaded connectors
Points, caps, and threaded connectors shall be boxed separately in 100 unit lots.
- c. All rod boxes will be made from single wall cardboard - 275 lbs. per square inch bursting test strength, and other boxes shall be 200 lbs. minimum. Boxes shall not be longer than 4'.
- d. Boxes will be strapped with heat sealed plastic strapping to avoid bursting due to moisture or handling. At least 3 straps will be placed around the rod boxes.

Regulation Aluminum Driven-Type Rotating 3/4" Rod Monument,
Specification No. 9691.42

Standard packing "B-Bundle" will include:

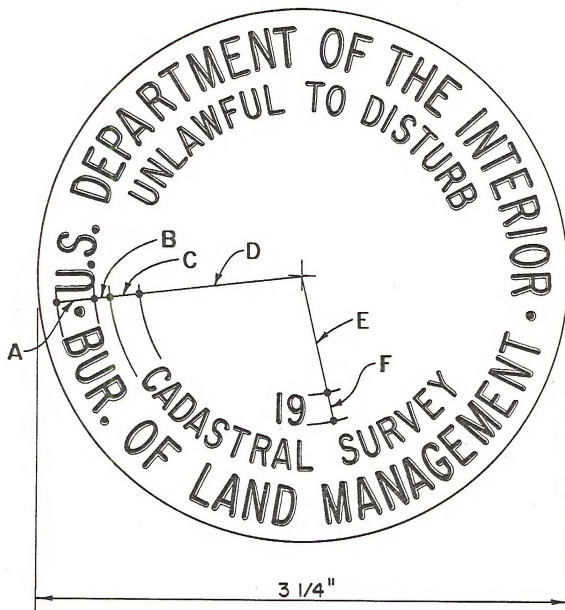
- a. (1) 20 Rod sections (36 inch length), with a connector screw installed in one end of each rod, both rod ends capped in plastic.
- (2) 10 Monument caps
- (3) 10 Points
- (4) 5 Extra threaded connectors in a plastic bag.
- b. Boxes shall not be longer than 4' , and shall be constructed from single-wall cardboard - 275 lbs. per square inch bursting test strength.
- c. Boxes shall be strapped with heat-sealed plastic strapping to avoid bursting due to moisture or handling. At least 3 straps will be placed around the rod boxes.

8. Marking for Shipment:

Each box of survey monument components shall have a sturdy self-adhesive tag securely attached to the outside in a prominent location. The tag shall contain the following information: Address and destination; contract number; item nomenclature; contractor's name; date of shipment; total quantity each in the shipment; and gross weight.

REGULATION ALUMINUM DRIVEN-TYPE ROTATING 3/4" ROD MONUMENT

Specification No. 9691.42



A	B	C	D	E	F
$\frac{1}{4}"$	$\frac{1}{16}"$	$\frac{3}{16}"$	$1"$	$\frac{11}{16}"$	$\frac{3}{16}"$

Specification No. 9691.42



BOTTOM VIEW

NOTE:
NORMAL CASTING TOLERANCES
ARE ACCEPTABLE $\pm 1/32"$

REGULATION ALUMINUM DRIVEN-TYPE ROTATING 3/4" ROD MONUMENT

Specification No. 9691.42

2 EACH, DRILL AND TAP TO ACCEPT
7/16" x 14 NC-1A-RH SCREW

MACHINE
FACED

SCRATCH
MARK

36" ± 1/4"

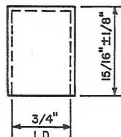
SCRATCH
MARK

MACHINE
FACED

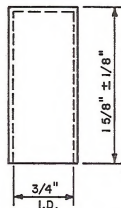
3/4" DIA.
± .010

SECTIONAL ROD

TOP

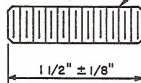


BOTTOM



PROTECTIVE PLASTIC CAPS

7/16" x 14 NC-1A-RH THREADS



FLOATING ATTACHMENT SCREW

NOTE :

THE POINT SECTION SHALL BE DRILLED AND TAPPED
SO THAT IT MAY BE ATTACHED TO THE ROD BY THE
FLOATING ATTACHMENT SCREW.
THE ROD POINT MAY VARY IN DESIGN; HOWEVER,
POINT DESIGN SHALL BE SUCH THAT THE ROD STRING
IS TIGHTENED AS IT IS DRIVEN.

POINT SECTION

U.S. Department of the Interior
Bureau of Land Management
Cadastral Survey
Washington, D.C.

Regulation Aluminum Pipe Monument, Specification No. 9691.43

1. General: See Drawings

This specification is similar to the Regulation Iron Pipe Monument as found in Chapter IV-7 of the Manual of Instructions for the Survey of the Public Lands of the United States - 1973, Department of the Interior Technical Bulletin No. 6, referred to as The Manual. The significant difference is that this specification is for an all-aluminum monument rather than an iron pipe-brass cap monument. The overall physical size of this monument is nearly identical to the standard iron monument. The aluminum monument weighs about 3 pounds.

2. Monument Cap:

The monument cap will be ALMAG 35, Alloy 535.0; QQ-A601E's, or latest revisions.

Composition: Aluminum - 92-93%; Magnesium - 6.5-7.5%

Strength: Yield - 19,000-21,000 psi; Tensile - 38,000-44,000 psi;

Elongation - 10-15% (in two inches).

Cap dimensions are shown on the drawing (see Drawing No. 2). The surface shall be smooth and have medium gloss, polish-like finish. The cap shall have a socket portion which is specially shaped to force fit over the pipe's upper end. The cap is held in place by a solid aluminum rivet. Pipe, cap and rivet are metallurgically similar.

The standard Cadastral Survey inscription will be cast into the cap, as specified in the drawing (see Drawing No. 1). All letters and numbers shall have clean, unbroken lines, and be clear and legible. A sample cap showing the quality of inscription and degree of polish acceptable under terms of this contract is available for inspection at the Bureau of Land Management, Denver Service Center, Building 50, Denver Federal Center, Denver, Colorado 80225.

A forged monument cap is also acceptable and is described as follows:

Cap material will be the same material as the rod section material (Alloy 6063) and a temper of T5 will be acceptable.

Composition: Aluminum - 97-98%; Magnesium - 0.5-1%

Silicon - 0.25-0.50%; Other - less than 1%

Cap dimensions are the same as those for the cast cap above and are shown on Drawing No. 2.

Regulation Aluminum Pipe Monument, Specification No. 9691.43

The standard Cadastral Survey inscription shall be formed into the caps as shown on Drawing No. 1. All letters and numbers shall have clean, unbroken lines, and be clear and legible.

2b. Monument Cap Magnet:

The monument cap shall have a ceramic magnet permanently attached by either epoxy, mechanical fastener or both within the pipe socket. The magnet shall have a field strength of 50 (± 5) gammas* and a detection range of 3.5 feet. Detection range is based on the use of a model GA-52B locator or equivalent. Recommended magnet dimensions and mounting is shown on the drawings (see Drawing No. 2 and 3).

3. Cap Rivet:

The cap rivet will be a 3/16" x 3" Flat or Oval Head Rivet, Alloy 6061-T6 Aluminum.

*one gamma = 1/100,000 gauss.

4a. Monument Pipe:

The pipe is made from Aluminum Alloy 6063-T6, Schedule 10 pipe; MIL-P-25995; ASTM B429 (or latest revision). The pipe shall be about 2-3/8" outside diameter, having a wall thickness of 7/64" (± 0.012 "), and is cut 30" long ($\pm 3/8$ ").

4b. Pipe Base:

The aluminum pipe base is shipped flared to a minimum width of approximately 5-1/2" (see Drawing No. 3). This style of monument allows the placement of additional sub-surface detection devices, such as magnetic markers, which would remain intact at the original point of survey in the event the monument was vandalized or pulled from the ground.

4c. Sub-surface magnet:

The sub-surface magnet that may be required for use with this monument shall be a ceramic magnet housed within a plastic container. The container shall be marked or color coded in a manner to indicate how the magnet should be placed. The magnet shall have a field strength of 550 (± 10) gammas* and a detection range up to 8 feet. Detection range is based on the use of a model GA-52B locator or equivalent. Recommended magnet dimensions are shown on the drawing (see Drawing No. 3).

*Note: One gamma = 1/100,000 gauss

Regulation Aluminum Pipe Monument, Specification No. 9691.43

5. Assembly:

The monument cap shall be pressed onto the top of the pipe with a firm fit and shall bottom inside the cap. The cap and pipe shall be drilled and fitted with a rivet prior to shipment (see Drawing No. 3). A matched through hole shall be drilled for the rivet by using a guided "v" block to assure the hole is drilled on the pipe center line. Sufficient edge material must be allowed to prevent the rivet hole from cracking out when the rivet is set.

6. Bundling for Shipment:

Pipe monuments shall be banded in units of 3 per bundle (see Drawing No. 3). The bundle shall be strapped with at least 2 bands of heat-sealed plastic strapping. The banding process shall keep the monuments in a side-by-side relation within each unit (see Drawing No. 3).

A pallet will consist of 60 bundles of 3 monuments each, totalling 180 monuments per skid; weight per skid not to exceed 550 pounds. Pallets shall be banded with at least 4 bands (2 bands N-S, and 2 bands E-W) of heat-sealed plastic strapping.

Note: Monument bundling requirements were designed to insure safe delivery and provide ease in handling.

Field offices may request deviations from these standard bundling requirements, if there is a need to do so. However, any deviations or revisions to the standard procedures must insure that the monuments will be received in a safe undamaged condition.

7. Marking for Shipment:

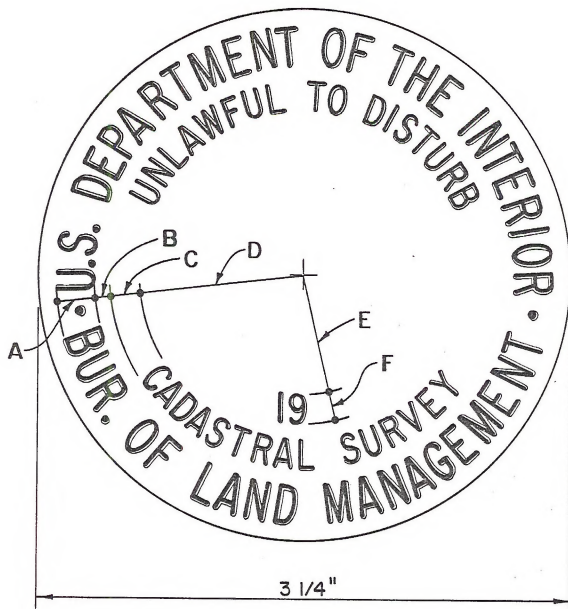
Each bundle of 3 survey monuments shall have a sturdy tag securely attached to the outside in a prominent location. The tag shall contain the following information:

Address and destination; contract number; item nomenclature; contractor's name and date of shipment; total quantity each in the shipment; and gross weight.



REGULATION ALUMINUM PIPE MONUMENT

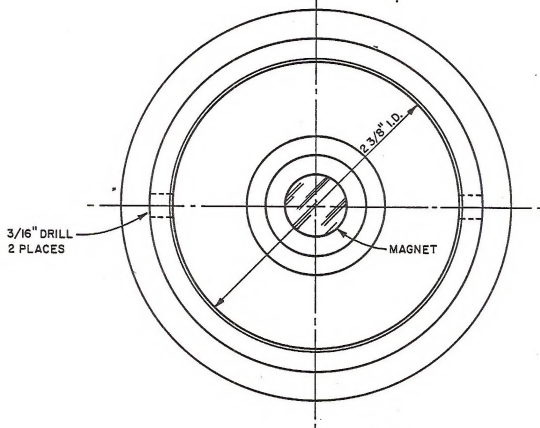
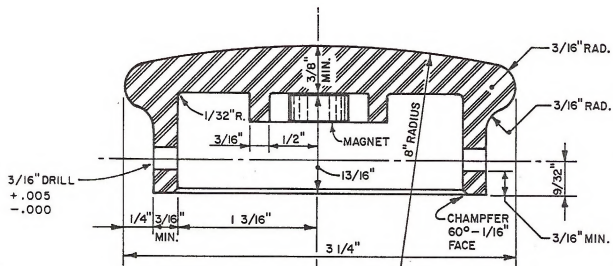
Specification No. 9691.43



A	B	C	D	E	F
$\frac{1}{4}"$	$\frac{1}{16}"$	$\frac{3}{16}"$	$1"$	$\frac{11}{16}"$	$\frac{3}{16}"$

REGULATION ALUMINUM PIPE MONUMENT

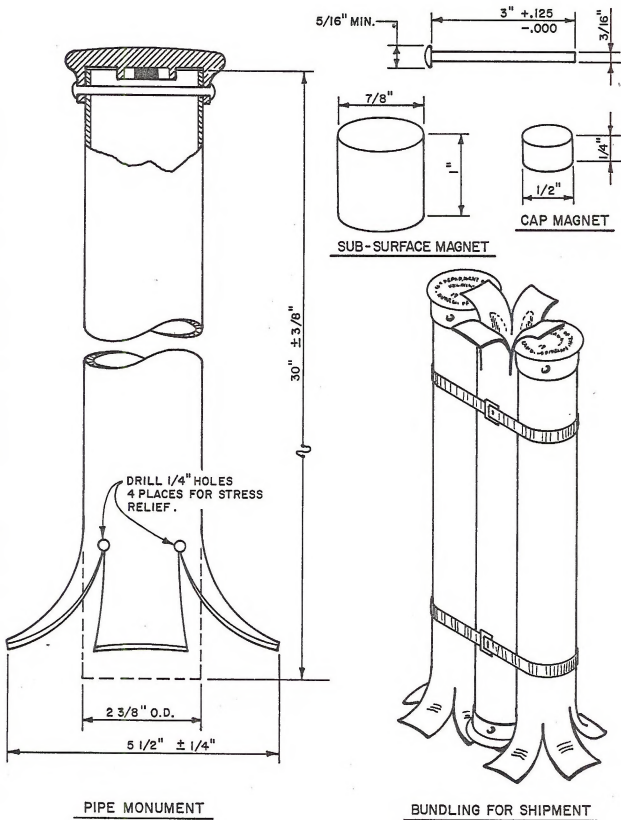
Specification No. 9691.43



NOTE:
NORMAL CASTING TOLERANCES
ARE ACCEPTABLE, $\pm 1/32"$

REGULATION ALUMINUM PIPE MONUMENT

Specification No. 9691.43





U.S. Department of the Interior
Bureau of Land Management
Cadastral Survey
Washington, D.C.

Regulation Stemmed Brass Cap Monument, Specification No. 9691.44

1. General: See Drawings

This specification refers to the stemmed brass tablet for placing in rock outcrop or concrete, as found in Chapter IV-7 of the Manual of Instructions for the Survey of the Public Lands of the United States - 1973, Department of the Interior Technical Bulletin No. 6, referred to as The Manual. The brass cap monument with a stem weighs about 1/2 pound.

2. Stemmed Cap:

The cap will be Brass Alloy 836, conforming to ASTM Spec. B 145-63-4A, or latest revisions. Chemical composition shall be 85% copper; 5% tin; 5% lead; and 5% zinc.

Cap dimensions are shown on the drawing (see Drawing No. 2). The surface shall be smooth and have medium gloss, polish-like finish. The caps shall have a stem which is integrally cast to the cap. The outward tip of the stem shall be bisected to a depth of about 1", and the tip shall be flared to about 3/4" outside diameter, to provide an interference-type fit in the monument receptacle.

The standard Cadastral Survey inscription will be cast into the caps as specified in the drawing (see Drawing No. 1). All letters and numbers shall have clean, unbroken lines, and be clear and legible. A sample cap showing the quality of inscription and degree of polish acceptable under terms of this contract is available for inspection at the Bureau of Land Management, Denver Service Center, Building 50, Denver Federal Center, Denver, Colorado 80225.

3. Boxing for Shipment:

Stemmed monument caps shall be boxed in units of 50 per box. Box shall be singlewall construction of 200 psi test bursting strength. Each box shall be strapped with at least 2 plastic bands of heat-sealed plastic strapping.

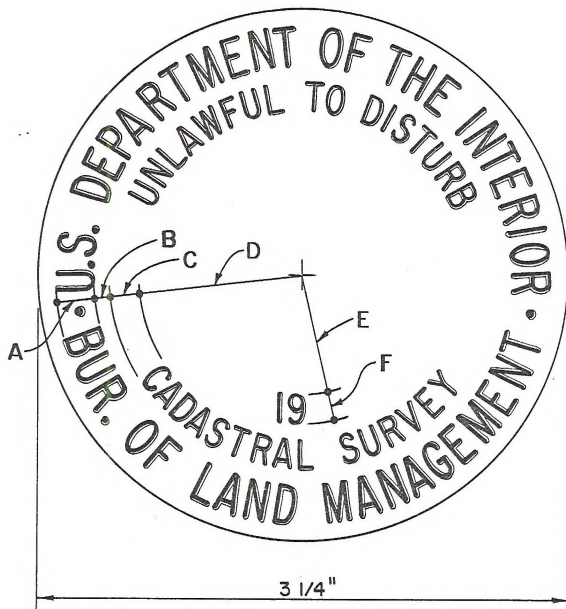
4. Marking of Shipment:

Each box of survey monument components shall have a sturdy self-adhesive tag securely attached to the outside in a prominent location. The tag shall contain the following information:

Address and destination; contract number; item nomenclature; contractor's name; date of shipment; total quantity each in the shipment; and gross weight.

REGULATION STEMMED BRASS CAP MONUMENT

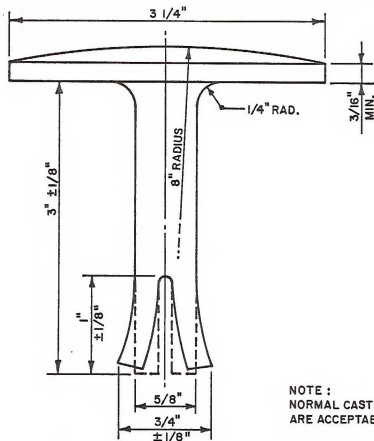
Specification No. 9691.44



A	B	C	D	E	F
1/4"	1/16"	3/16"	1"	11/16"	3/16"

REGULATION STEMMED BRASS CAP MONUMENT

Specification No. 9691.44



NOTE :
NORMAL CASTING TOLERANCES
ARE ACCEPTABLE, $\pm 1/32"$

U.S. Department of the Interior
Bureau of Land Management
Cadastral Survey
Washington, D.C.

Regulation Stainless Steel Drive - Type Rotating Rod Monument,
Specification No. 9691.45

1. General: See Drawings

The stainless steel survey monument is a permanent marker used in corrosive type soils by Cadastral Survey in areas of both high and low soil pH values. This monument is assembled in the field, the brass cap being driven onto the last rod section. A complete monument consists of a point section, a threaded connector screw, a rod section, and a brass cap (with magnet), and weighs about 4 pounds. Rod sections and connectors may be added to increase the length of the monument, so that the driven monument ultimately reaches a point of refusal.

2. Rod Monument Cap:

The brass cap shall be leaded, semi-red brass, Alloy 5A, conforming to ASTM Specification (B30)5 or equivalent. Alloy 5A, composition 81-3-7-9, has the following nominal chemical composition: 81% copper; 7% lead; 3% tin; and 9% zinc.

Cap dimensions are shown on the drawing. The surface shall be smooth and have a medium gloss, polished-like finish. The brass cap is a drive-on cap, and shall have a tapered socket to provide an interference-type fit.

The standard Cadastral Survey inscription shall be cast into the caps as specified in the drawing. All letters and numbers shall have clean, unbroken lines, and be clear and legible. A sample cap showing the quality of inscription and the degree of polish acceptable under terms of this contract is available for inspection at the Bureau of Land Management, Denver Service Center, Building 50, Denver Federal Center, Denver, Colorado 80225.

2. A forged monument cap is also acceptable and is described as follows:

Cap material must equal to or exceed the corrosion resistant properties of Brass Alloy ASTM (B-30)5 as listed above.

Cap dimensions are the same as those for the cast cap above and are as shown on Drawing No. 2.

The standard Cadastral Survey inscription shall be formed into the caps as shown on Drawing No. 1. All letters and numbers shall have clean, unbroken lines, and be clear and legible.

Regulation Stainless Steel Drive - Type Rotating Rod Monument,
Specification No. 9691.45

2b. Monument Cap Magnet:

The monument cap shall have a ceramic magnet permanently attached by either epoxy, mechanical fastener or both within the rod socket. The magnet shall have a field strength of 50 (± 5) gammas* and a detection range up to 3.5 feet. Detection range is based on the use of a model GA-52B locator or equivalent. Recommended magnet dimensions and mounting are shown on the drawings (see Drawing No. 2 and 3).

*one gamma = 1/100,000 gauss.

3. Rod Section:

Rod sections shall be Type 304 or Type 316 solid stainless steel. The nominal chemical composition of stainless steel Type 304 includes the following properties by percent: Carbon - .08% max; Manganese - 2.0% max; Silicon - 1.0% max; Chromium - 18.0 - 20.0%; Nickel - 08.0 - 12.0% Molybdenum - 2.0 - 3.0%.

Rod sections shall be 5/8" in diameter x 36" long. Both ends of each rod section shall be machine faced perpendicular to the rod centerline, and shall be drilled and tapped to a depth of 3/4" on the centerline, for a 3/8" x 16NC x RH thread. A "scratch" mark (grooved ring) shall be machined 1" from each end of the rod. A threaded connector screw shall be installed in one end of each rod prior to shipment.

4. Threaded Connectors:

Threaded connector screws, or floating connectors, shall be Type 304 or Type 316 Stainless Steel, identical material to, and specified under Paragraph 3, "Rod Section:", in order to minimize galvanic action.

Threaded connectors shall measure 3/8" x 1-3/8" long, having 16 threads per inch RH. The threaded connectors shall be installed in the rod sections for shipping (except for spares) and capped with plastic caps.

5. Plastic End Caps:

Rod sections shall be capped with large and small protective plastic end caps of sufficient length to protect rod ends and threaded connector screw. See drawing for dimensioning details. The large end cap is to be placed on the end having the threaded connector.

End caps shall be manufactured from low density polyethelene, conforming to Federal Specification L-P-390.

6. Point:

The point material shall be leaded, semi-red brass, Alloy 5A, conforming to ASTM Specification (B30)5 or equivalent. The base end of the point shall be machine faced perpendicular to the point centerline, and shall be drilled and tapped to a depth of 3/4" on the centerline, to accept a 3/8" x 16NC x RH thread.

Regulation Stainless Steel Drive - Type Rotating Rod Monument,
Specification No. 9691.45

The rod point may vary in design. The point shall be designed so that it will tighten the rod string as it is driven into the ground and provide resistance if a rod is pulled on. New point designs (that have not previously been used) shall be approved prior to production. Points may be shipped to Bureau of Land Management, Denver Service Center, Building 50, Denver Federal Center, Denver, Colorado 80225 for approval.

7. Packaging:

Standard Packaging "A-Bundle" will include:

- a. 5 each, Boxes of 36 inch rod sections. Each box will contain 20 rods with a connector screw installed in one end of each rod, and shall be protected by plastic caps on each rod end.
- b. 1 each, Box of points.
1 each, Box of caps.
1 each, Box of threaded connectors
Points, caps, and threaded connectors shall be boxed separately in 100 unit lots.
- c. All rod boxes will be made from single wall cardboard - 275 lbs. per square inch bursting test strength, and other boxes shall be 200 lbs. minimum. Boxes shall not be longer than 4'.
- d. Boxes will be strapped with heat sealed plastic strapping to avoid bursting due to moisture or handling. At least 3 straps will be placed around the rod boxes.

Standard packing "B-Bundle" will include:

- a. (1) 20 Rod sections (36 inch length), with a connector screw installed in one end of each rod, both rod ends capped in plastic.
(2) 10 Monument caps
(3) 10 Points
(4) 5 Extra threaded connectors in a plastic bag.
- b. Boxes shall not be longer than 4' , and shall be constructed from single-wall cardboard - 275 lbs. per square inch bursting test strength.
- c. Boxes shall be strapped with heat-sealed plastic strapping to avoid bursting due to moisture or handling. At least 3 straps will be placed around the rod boxes.

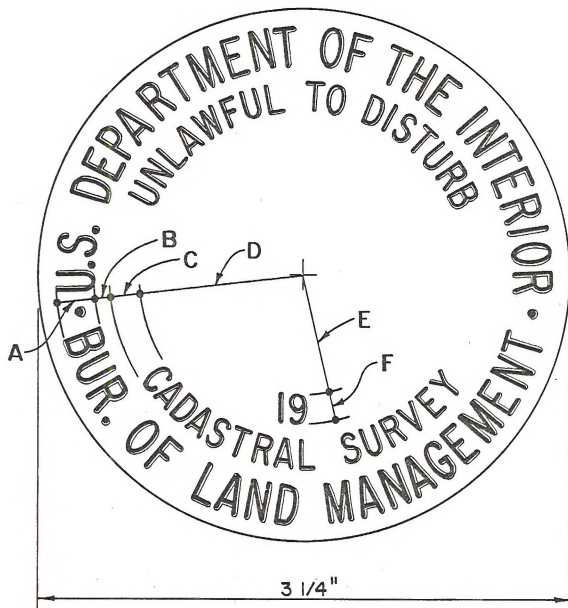
8. Marking for Shipment:

Each box of survey monument components shall have a sturdy self-adhesive tag securely attached to the outside in a prominent location. The tag shall contain the following information: Address and destination; contract number; item nomenclature; contractor's name; date of shipment; total quantity each in the shipment; and gross weight.



REGULATION STAINLESS STEEL DRIVEN-TYPE ROTATING ROD MONUMENT

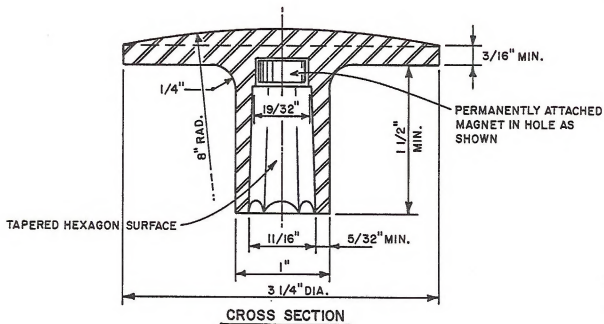
Specification No. 9691.45



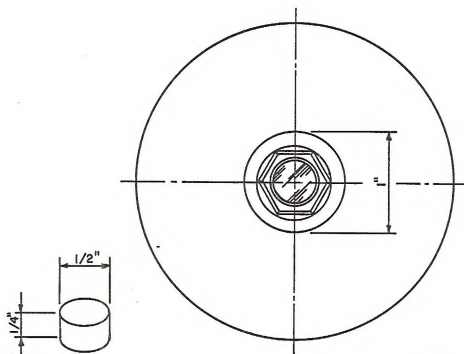
A	B	C	D	E	F
1/4"	1/16"	3/16"	1"	11/16"	3/16"

REGULATION STAINLESS STEEL DRIVEN-TYPE ROTATING ROD MONUMENT

Specification No. 9691.45



LOGO CAP



CAP MAGNET

BOTTOM VIEW

NOTE:
NORMAL CASTING TOLERANCES
ARE ACCEPTABLE $\pm 1/32"$



REGULATION STAINLESS STEEL DRIVEN-TYPE ROTATING ROD MONUMENT

Specification No. 9691.45

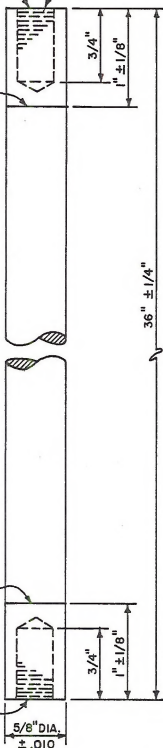
2 EACH, DRILL AND TAP TO ACCEPT
3/8" x 16 NC-1A-RH SCREW

MACHINE
FACED

SCRATCH
MARK

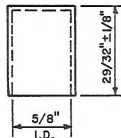
SCRATCH
MARK

MACHINE
FACED

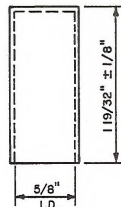


SECTIONAL ROD

TOP

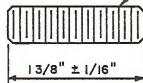


BOTTOM



PROTECTIVE PLASTIC CAPS

3/8" x 16 NC-1A-RH THREADS



FLOATING ATTACHMENT SCREW

NOTE :

THE POINT SECTION SHALL BE DRILLED AND TAPPED SO THAT IT MAY BE ATTACHED TO THE ROD BY THE FLOATING ATTACHMENT SCREW. THE ROD POINT MAY VARY IN DESIGN ; HOWEVER, POINT DESIGN SHALL BE SUCH THAT THE ROD STRING IS TIGHTENED AS IT IS DRIVEN.

POINT SECTION

U.S. Department of the Interior
Bureau of Land Management
Cadastral Survey
Washington, D.C.

Regulation Aluminum Driven-Type Rotating 5/8" Rod Monument,
Specification No. 9691.46

1. General: See Drawings

The aluminum rod monument is often used in wet marshy areas where pipe monuments can not reach firm soil. The rod monument is also used in loose soils where pipe monuments may be frost-heaved. This monument is also light and convenient to use where packing-in or other logistics requirements demand. This monument is assembled in the field, the aluminum cap being driven onto the last rod section. A complete monument consists of a point, threaded connector screw, a rod section, and an aluminum cap (with magnet), and weighs about one-half pound. Rod sections and connectors may be added to increase the length of the monument so that the drive monument ultimately reaches a point of refusal.

2. Rod Monument Cap:

Monument cap alloy will be ALMAG 35. Alloy 535.0; QQ-A-601E's; or latest revisions.

Composition: Aluminum - 92-93%; Magnesium - 6.5-7.5%
Strength: Yield - 19,000-21,000 psi; Tensile - 38,000-44,000 psi
Elongation - 10-15% (in two inches)

Cap dimensions are shown on the drawing. The surface shall be smooth and have a medium gloss, polished-like finish. The caps shall have a socket portion which has a slightly tapered, longitudinally fluted inside surface, specially shaped and adapted to fit over the uppermost rod section end. This socket configuration effectively prevents air pockets and provides an easy fitting, yet tight compression connection when the cap is tapped onto the rod section.

The standard Cadastral Survey inscription will be cast into the caps, as specified in the drawing. All letters and numbers shall have clean, unbroken lines, and be clear and legible. A sample cap showing the quality of inscription and degree of polish acceptable under terms of this contract is available for inspection at the Bureau of Land Management, Denver Service Center, Building 50, Denver Federal Center, Denver, Colorado 80225.

A forged monument cap is also acceptable and is described as follows:

Cap material will be the same material as the rod section material (Alloy 6063) and a temper of T5 will be acceptable.

Composition: Aluminum - 97-98%; Magnesium - 0.5-1%
Silicon - 0.25-0.50%; Other - less than 1%

Regulation Aluminum Driven-Type Rotating 5/8" Rod Monument,
Specification No. 9691.46

Cap dimensions are the same as those for the cast cap above and are shown on Drawing No. 2.

The standard Cadastral Survey inscription shall be formed into the caps as shown on Drawing No. 1. All letters and numbers shall have clean, unbroken lines, and be clear and legible.

2b. Monument Cap Magnet:

The monument cap shall have a ceramic magnet permanently attached by either epoxy, mechanical fastener or both within the rod socket. The magnet shall have a field strength of 50 ($\pm$ 5) gammas* and a detection range up to 3.5 feet. Detection range based on the use of a model GA-52B locator or equivalent. Recommended magnet dimensions and mounting is shown on the drawings (see Drawing No. 2 and 3).

*one gamma = 1/100,000 gauss.

3. Rod Section:

Rod section shall be Alloy and Temper 6063-T6 solid extrude rod; QQ-A-200/9; SAE 4156; ASM 4156 B221; ANSI H38.5; or latest revisions.

Composition: Aluminum - 97-98%; Magnesium - 0.5-1%;

Silicon - 0.25-.050%; Other - less than 1%

Strength: Yield - 25.0-30.0 kpsi; Tensile - 39.0-36.0 kpsi

Elongation - 12% (in two inches)

Rod sections shall be 5/8" in diameter (± 0.010 ") x 36" long. Both ends of each rod section shall be machine faced perpendicular to the rod centerline, and shall be drilled and tapped to a depth of 3/4" on the centerline to accept a 3/8" x 16NC x RH thread. A "scratch" mark (grooved ring) shall be machined 1" from each end of the rod. A threaded connector screw shall be installed in one end of each rod prior to shipment.

4. Threaded Connectors:

Threaded connector screws, or floating connectors, shall be Type 347 Stainless Steel or equivalent.

Threaded connectors shall measure 3/8" x 1-3/8" long, having 16 threads per inch RH. The threaded connectors shall be installed in the rod sections for shipping (except for spares), and capped with plastic caps.

5. Plastic End Caps:

Rod sections shall be capped with large and small protective plastic end caps of sufficient length to protect rod ends and threaded connector screw. See drawing for dimensioning details. The large end cap is to be placed on the end having the threaded connector.

Regulation Aluminum Driven-Type Rotating 5/8" Rod Monument,
Specification No. 9691.46

End caps shall be manufactured from low density polyethelene, conforming to Federal Specification L-P-390 or equivalent.

6. Point:

Point alloy may be ALMAG 35, identical material to, and specified under Paragraph 2, "Rod Monument Caps" or Aluminum Alloy 6063-T6.

The base end of the point shall be machine faced perpendicular to the point centerline, and shall be drilled and tapped to a depth of 3/4" on the centerline, to accept a 3/8" x 16NC x RH thread. The rod point may vary in design. The point shall be designed so that it will tighten the rod string as it is driven into the ground and provide resistance if a rod is pulled on. New point designs (that have not previously been used) shall be approved prior to production. Points may be shipped to Bureau of Land Management, Denver Service Center, Building 50, Denver Federal Center, Denver, Colorado 80225 for approval.

7. Packaging:

Standard packaging "A-bundle" will include:

- a. 5 each, Boxes of 36 inch rod sections. Each box will contain 20 rods with a connector screw installed in one end of each rod, and shall be protected by plastic caps on each rod end.
- b. 1 each, Box of points
1 each, Box of caps
1 each, Box of threaded connectors
Points, caps, and threaded connectors shall be boxed separately in 100 unit lots.
- c. All rod boxes will be made from single wall cardboard - 275 lbs. per square inch bursting test strength, and other boxes shall be 200 lbs. minimum. Boxes shall not be longer than 4'.
- d. Boxes will be strapped with heat sealed plastic strapping to avoid bursting due to moisture or handling. At least 3 straps will be placed around the rod boxes.

Standard packing "B-Bundle" will include:

- a. (1) 20 Rod sections (36 inch length), with a connector screw installed in one end of each rod, both rod ends capped in plastic.
- (2) 10 Monument caps
- (3) 10 Points

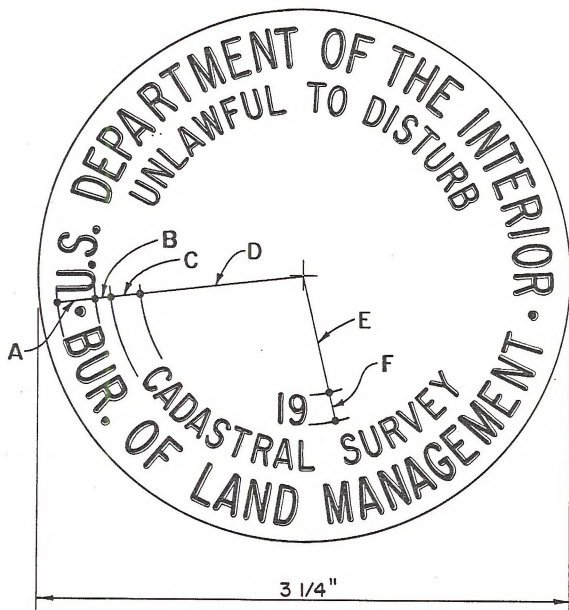
Regulation Aluminum Driven-Type Rotating 5/8" Rod Monument,
Specification No. 9691.46

- (4) 5 Extra threaded connectors in a plastic bag.
 - b. Boxes shall not be longer than 4' , and shall be constructed from single-wall cardboard - 275 lbs. per square inch bursting test strength.
 - c. Boxes shall be strapped with heat-sealed plastic strapping to avoid bursting due to moisture or handling. At least 3 straps will be placed around the rod boxes.
8. Marking for Shipment:

Each box of survey monument components shall have a sturdy self-adhesive tag securely attached to the outside in a prominent location. The tag shall contain the following information: Address and destination; contract number; item nomenclature; contractor's name; date of shipment; total quantity each in the shipment; and gross weight.

REGULATION ALUMINUM DRIVEN-TYPE ROTATING 5/8" ROD MONUMENT

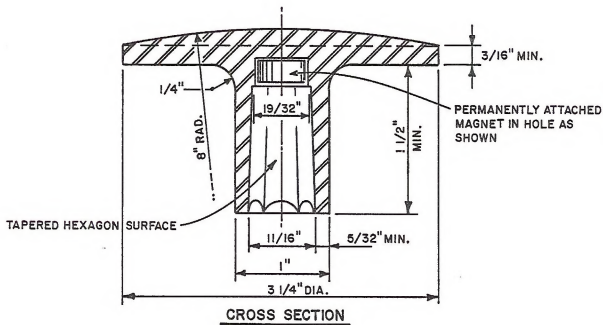
Specification No. 9691.46



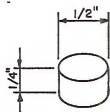
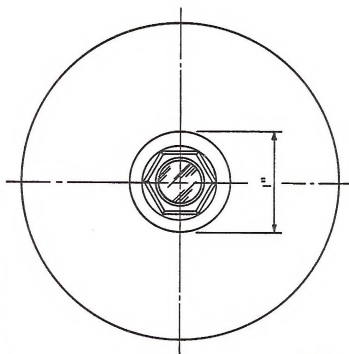
A	B	C	D	E	F
1/4"	1/16"	3/16"	1"	11/16"	3/16"

REGULATION ALUMINUM DRIVEN-TYPE ROTATING 5/8" ROD MONUMENT

Specification No. 9691.46



LOGO CAP



NOTE:
NORMAL CASTING TOLERANCES
ARE ACCEPTABLE $\pm 1/32"$

REGULATION ALUMINUM DRIVEN-TYPE ROTATING 5/8" ROD MONUMENT

Specification No. 9691.46

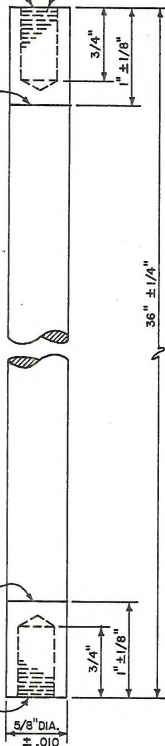
2 EACH, DRILL AND TAP TO ACCEPT
3/8" x 16 NC-1A-RH SCREW

MACHINE
FACED

SCRATCH
MARK

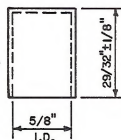
SCRATCH
MARK

MACHINE
FACED

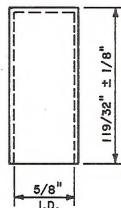


SECTIONAL ROD

TOP

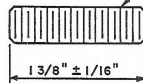


BOTTOM



PROTECTIVE PLASTIC CAPS

3/8" x 16 NC-1A-RH THREADS



FLOATING ATTACHMENT SCREW

NOTE :

THE POINT SECTION SHALL BE DRILLED AND TAPPED SO THAT IT MAY BE ATTACHED TO THE ROD BY THE FLOATING ATTACHMENT SCREW. THE ROD POINT MAY VARY IN DESIGN; HOWEVER, POINT DESIGN SHALL BE SUCH THAT THE ROD STRING IS TIGHTENED AS IT IS DRIVEN.

POINT SECTION

U.S. Department of the Interior
Bureau of Land Management
Cadastral Survey
Washington, D.C.

Regulation Stainless Steel Pipe Monument, Specification No. 9691.47

1. General: See Drawings

This specification is similar to the regulation Iron Pipe Monument as found in Chapter IV-7 of the Manual of Instructions for the Survey of the Public Lands of the United States - 1973, Department of the Interior Technical Bulletin No. 6, referred to as The Manual. The significant difference is that this specification is for a stainless steel monument rather than an iron pipe-brass cap monument. The overall physical size is nearly identical. The stainless steel monument weighs about 8-1/2 pounds.

2. Monument Cap:

The monument cap will be Brass, Alloy 5A, conforming to ASTM (B-30)5 or equivalent. Alloy 5A has the following chemical composition: 81% copper; 3% tin; 7% lead; and 9% zinc.

Cap dimensions are shown on the drawing (see Drawing No. 2). The surface shall be smooth and have medium gloss, polish-like finish. The cap shall have a socket portion which is specially shaped to force fit over the outside diameter of the pipe's upper end. The cap is held in place on the pipe by a solid stainless steel rivet.

The standard Cadastral Survey inscription will be cast into the cap, as specified in the drawing (see Drawing No. 1). All letters and numbers shall have clean, unbroken lines, and be clear and legible. A sample cap showing the quality of inscription and degree of polish acceptable under terms of this contract is available for inspection at the Bureau of Land Management, Denver Service Center, Building 50, Denver Federal Center, Denver, Colorado 80225.

2b. Monument Cap Magnet:

The monument cap shall have a ceramic magnet permanently attached by either epoxy, mechanical fastener or both within the rod socket. The magnet shall have a field strength of 50 ($\pm$ 5) gammas* and a detection range up to 3.5 feet. Detection range based on the use of a model GA-52B locator or equivalent. Recommended magnet dimensions and mounting is shown on the drawings (see Drawing No. 2 and 3).

*one gamma = 1/100,000 gauss.

3. Pipe Cap Rivet:

The cap rivet will be a 3/16" x 3" Flat or Oval Head Rivet, solid Stainless Steel, Type 304 or equivalent.

Regulation Stainless Steel Pipe Monument, Specification No. 9691.474a. Monument Pipe:

The pipe is made from Type 304 or Type 316 Stainless Steel, Schedule 10 pipe. The pipe shall be about 2-3/8" outside diameter and is cut 30" long.

4b. Pipe Base:

The pipe base is shipped flared to a minimum width of approximately 5-1/2" (see Drawing No. 3). This style of monument allows the placement of additional sub-surface detection devices, such as magnetic markers, which would remain intact at the original point of survey in the event the monument is vandalized or pulled from the ground.

4c. Sub-surface magnet:

The sub-surface magnet that may be required for use with this monument shall be a ceramic magnet housed within a plastic container. The container shall be marked or color coded in a manner to indicate how the magnet should be placed. The magnet shall have a field strength of 550 (± 10) gammas* and a detection range up to 8 feet. Detection range is based on the use of a model GA-52B locator or equivalent. Recommended magnet dimensions are shown on the drawing (see Drawing No. 3).

5. Assembly:

The pipe mating surfaces shall be coated for a distance of approximately 1 1/4 inches from the end with asphalt primer, conforming to Federal Specification SSA-701, prior to assembly. The monument cap shall be pressed onto the top of the pipe with a firm fit and shall bottom inside the cap. The cap and pipe shall be drilled and fitted with a rivet prior to shipment. A matched through hole shall be drilled for the rivet by using a guided "V" block to assure the hole is drilled on the pipe center line. Sufficient edge material must be allowed to prevent the rivet hole from cracking out when the rivet is set.

6. Bundling for Shipment:

Pipe monuments shall be banded in units of 3 per bundle (see Drawing No. 3). The bundle shall be strapped with at least 2 bands of heat-sealed plastic strapping. The banding process shall keep the monuments in a side-by-side relation within each unit.

A pallet will consist of 50 bundles of 3 monuments each, totalling 150 monuments per skid; weight per skid shall be approximately 1275 pounds. Pallets shall be banded with at least 4 bands (2 bands N-S, and 2 bands E-W) of heat-sealed plastic strapping.

*one gamma = 1/100,000 gauss

Regulation Stainless Steel Pipe Monument, Specification No. 9691.47

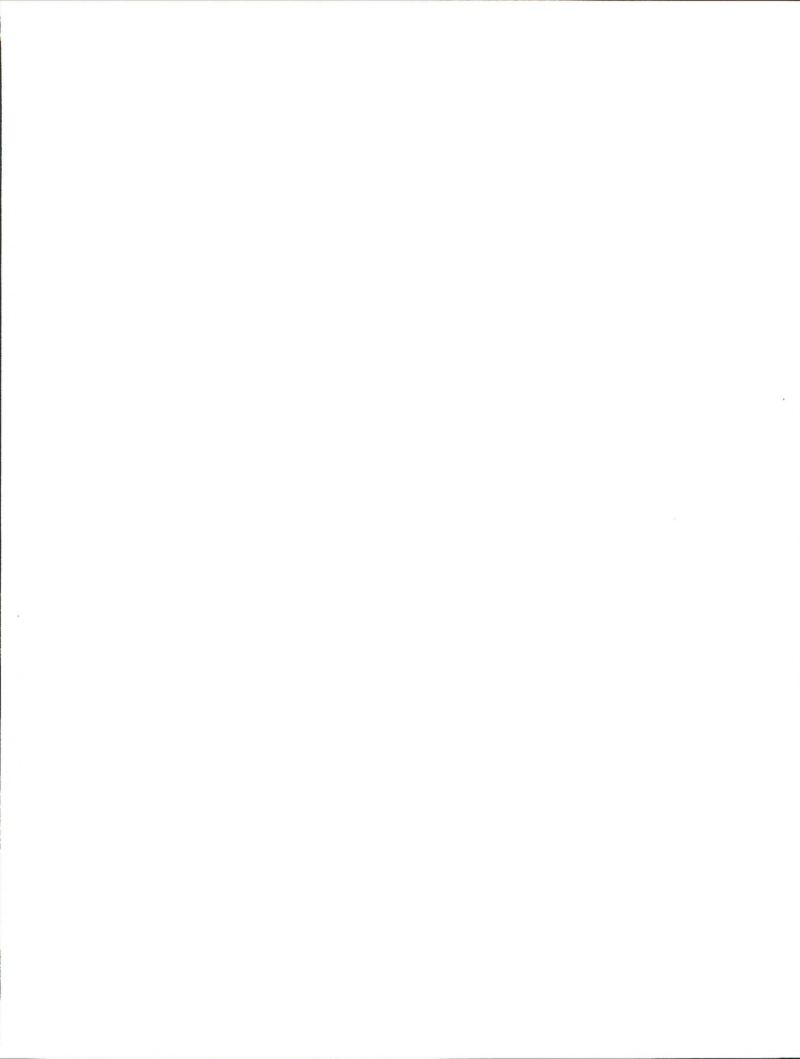
Note: Monument bundling requirements were designed to insure safe delivery and provide ease in handling.

Field offices may request deviations from these standard bundling requirements, if there is a need to do so. However, any deviations or revisions to the standard procedures must insure that the monuments will be received in a safe undamaged condition.

7. Marking for Shipment:

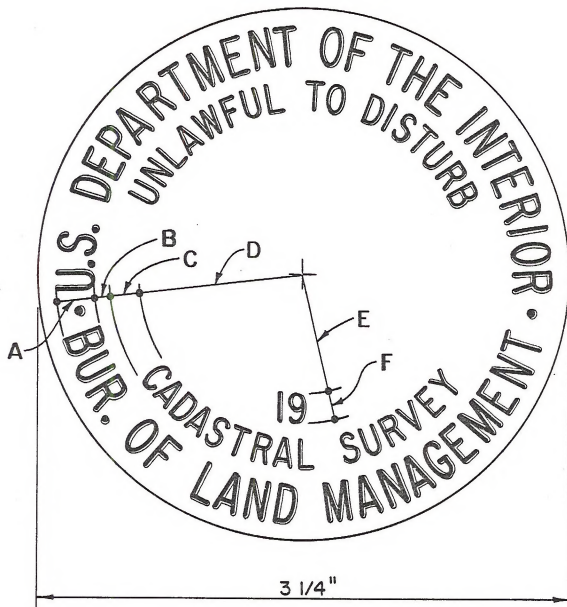
Each bundle of 3 survey monuments shall have a sturdy tag securely attached to the outside in a prominent location. The tag shall contain the following information.

Address and destination; contract number; item nomenclature; contractor's name and date of shipment; total quantity each in the shipment; and gross weight.

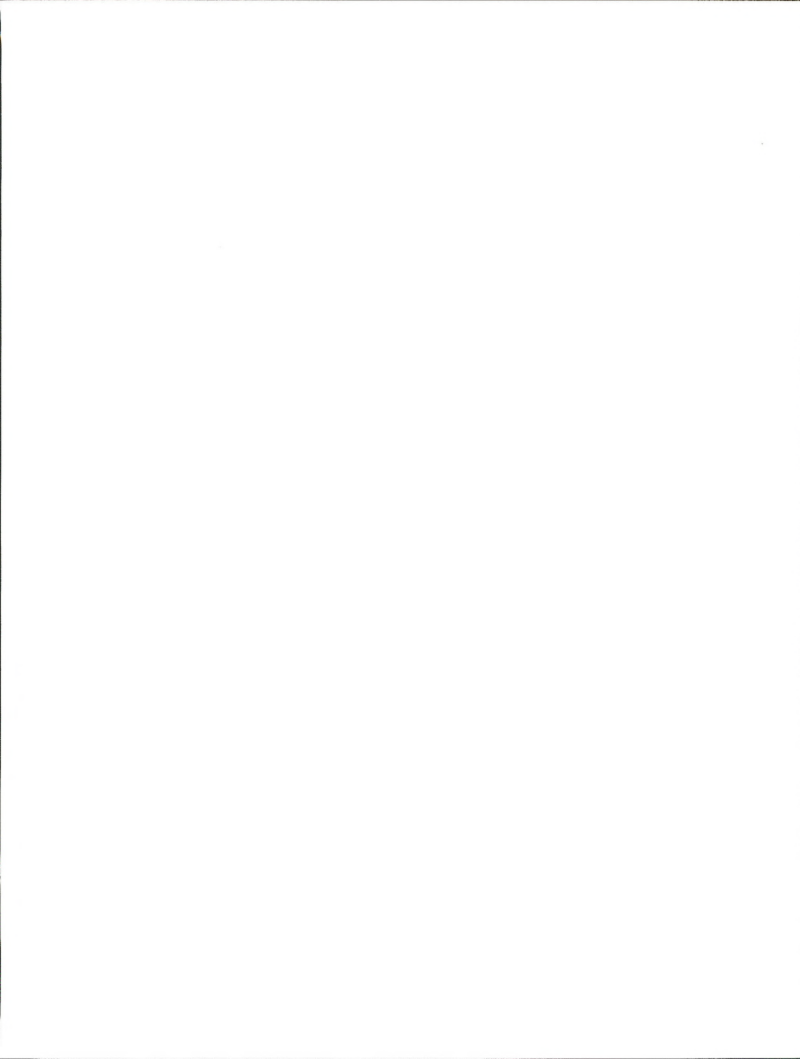


REGULATION STAINLESS STEEL PIPE MONUMENT

Specification No. 9691.47



A	B	C	D	E	F
1/4"	1/16"	3/16"	1"	11/16"	3/16"

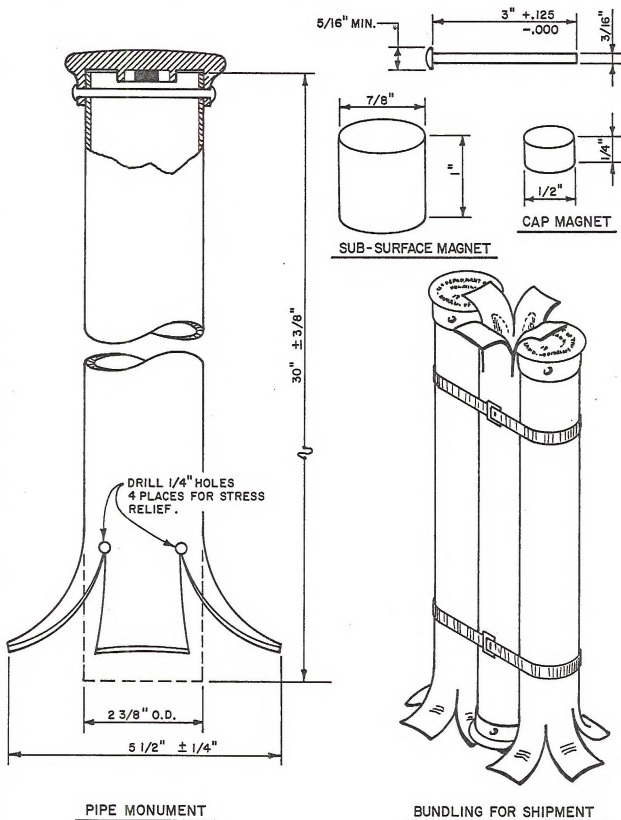


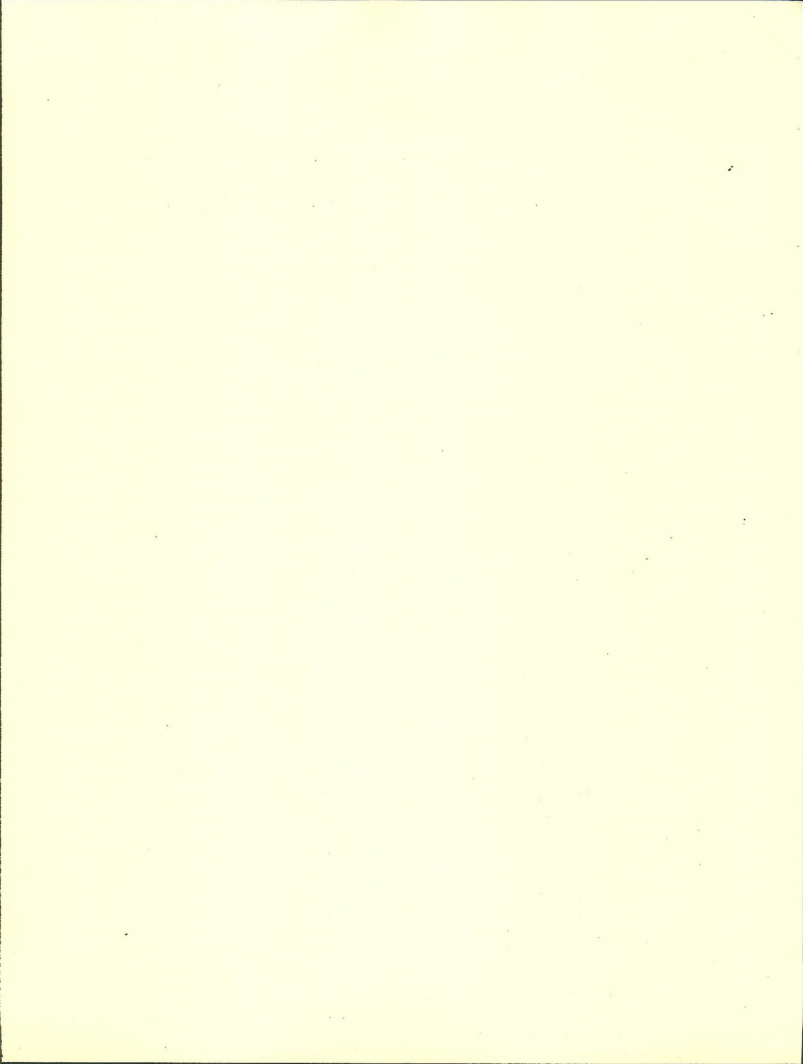
Specification No. 9691.47



REGULATION STAINLESS STEEL PIPE MONUMENT

Specification No. 9691.47







OPTIONAL LOGO



NOTE:

Add this optional cap to:

1. Stainless steel pipe monument
2. Aluminum pipe monument
3. Stemmed brass cap monument



CHAPTER IX.

MONUMENT QUALITY CONTROL
PROCEDURES

Monument Quality Control

I. Introduction

The Bureau of Land Management (BLM) has spent much time and effort in developing excellent survey monuments. The physical shape and design of each type monument is as important as the materials that have been developed to resist various types of corrosion, temperature extremes, etc.

Based upon research development, laboratory testing, and actual field use, BLM has developed and written standard specifications that will insure that high quality monuments are provided. One further step needs to be taken, however. BLM must provide a means to insure that all suppliers of BLM monuments will comply with the BLM standard specifications. To insure that this important function is carried out, it is recommended that BLM establish a quality control program to maintain a closer surveillance over survey monuments.

II. Quality Control Plan:

A. Ordering Monuments:

1. New Suppliers - Prior to making the first production run, the supplies should send two sample monuments to the Denver Federal Center for testing and metallurgical evaluation.

2. Old Suppliers - (Currently Certified Suppliers)

a. Ordering 0-100 monuments:

Testing will not be required.

b. Ordering 100 or more monuments:

Send one monument from the lot to the Denver Service Center for testing and evaluation.

B. Random Field Inspections:

1. A qualified representative from the Denver Service Center,

Registered Professional Engineer, shall visit at least two BLM field offices each year. A visual inspection will be made of the monuments on hand at each site. Any monument suspected of not meeting BLM standard specifications, will be shipped to Denver for testing. All test results including a metallurgical analysis will be returned to the applicable field office on a timely basis.

2. On an annual basis, at least one randomly selected monument will be taken from a field office and forwarded to Denver for testing. This testing will include making physical dimensional measurements as well as conducting a metallurgical analysis.

3. The results of monument testing will be forwarded to all State Cadastral Survey offices as well as to the Washington Office. Each report shall compare test monument findings with BLM standard specification requirements.

C. Vendor Facilities:

A qualified representative from the Denver Service Center shall visit one BLM monument supplies facilities each year. The purpose of this visit is to insure that both manufacturing procedures and materials being used comply with BLM high quality standards.

III. Field Office Requests:

If a field office feels that a monument does not meet BLM standards or if a new shipment of monuments is questioned, a sample monument should be sent to the Denver Service Center for analysis.

Upon receiving the questionable monument, DSC will thoroughly inspect and analyze the monument. A complete report will be returned to the field office that compares all test results with BLM specifications. In the event the monument fails to meet BLM specifications an alert will be issued to all State Cadastral Survey offices advising them of the problems and the manufacturer that is involved.

IV. Conclusion:

A properly conducted quality control program will insure that high quality monuments (both materials and workmanship) are being used throughout BLM. Implementing this program will be very inexpensive and may prevent the installation of substandard monuments.

CHAPTER X.

MONUMENT TEST SITES

MONUMENT TEST BEDS

I. Introduction

An important aspect of monumentation is to stay abreast of metallurgical research and to insure that state-of-the-art materials are being used. In addition to this type of study and research (laboratory conditions), a more basic evaluation should be ongoing to thoroughly evaluate existing materials. Actual field environment type tests should be made. One of the best ways to accomplish this task is to establish field test beds. Some test beds should be established to evaluate corrosion progression on various types of materials. These beds should be established in varying soil types such as acids, alkalines, and salts. Test beds should also be set up in cold climates where frost-heave has been a problem. Test beds should also be established in areas where water overflow covers monuments during various periods.

Once test beds are established, they should be inspected on a regular basis and accurate records must be maintained.

Test Bed Records should include the following as a minimum:

1. Monument Type:

Record the type of monument such as rod, pipe, finned rod, or stemmed and give the manufacturer.

2. Monument Dimensions:

Record the diameter of rod or pipe and give the overall length of the monument.

3. Installation date:

Record the date the monument was set and record the inspection date.

4. Installation procedure:

Describe how the monument was installed. If a rod was driven into position, list any special equipment that was used. If the monument was backfilled, given the material used to backfill the hole.

5. Monument material:

Record the monument material such as aluminum Type 6063T6, Stainless Steel Type 304, PVC, etc.

6. Environmental Conditions:

- a. Measure and record the soil PH
- b. Record the soil moisture content
- c. List temperature range the monument is likely to be subjected to.
- d. Record vegetation types if applicable.

7. Chemical reactions:

- a. Make an accurate description of the corroding conditions of each monument. Keep a record of corrosion progression by date.

- b. List materials that resist corrosion best.
- c. Be sure to tie corrosion to both material type and soil conditions.
- d. Take photographs where possible.

8. Frost-Heave Sites:

- a. Make an accurate record of the monument installation procedure. List any special equipment that was used to drive rods, etc.
- b. Record the overall length of each monument.
- c. Make a record of each monument type, material, and manufacturer.
- d. Measure and record the monument height above ground.
- e. Record inspection date.
- f. If a monument is backfilled, give the backfill procedure and list the backfill material, such as sand, rocks, gravel, etc.).
- g. List temperature range the monument is likely to be subjected to.

Note: Corrosion inspections should be made on two year intervals.

Frost-heave inspections should be made annually.

II. Alkaline Test Beds:

The Bureau of Land Management established two monument test beds in 1962 to monitor the effects of alkaline soils on various monument materials. All monument materials being used by BLM in 1962 were put in each test bed. Some

of the materials were black carbon, black yoloy, galvanized carbon, galvanized wrought iron, and galvanized yoloy. Both test sites were located near Salt Lake City, Utah. As new monument materials have been developed such as (fiberglass, PVC, carsonite, aluminum, and stainless steel) sample monuments have been added to the test beds for evaluation.

Regular inspections of these test beds have shown corrosion progression on each material and have allowed BLM Cadastral Survey to choose superior materials for their monuments.

III. Acid Test Beds:

In June 1983, a third test bed was established in an acid type soil in Shasta County, California. Due to vandalism this test site was destroyed and the remaining monuments were removed by Mr. John Brewer. At the time of removal, 1984, Mr. Brewer stated that there was severe corrosion on all monument materials except stainless steel, PVC, and carsonite. An acid test bed needs to be re-established and monitored on a regular basis. (See Test Site No. 3.)

IV. Frost Heave Test Beds:

In cold climates, especially Alaska, frost heave conditions have displaced some monuments. To date, investigations have failed to pin point the reasons for some monuments being frost-heaved while other monuments are unaffected. For this reason at least one and possibly two test beds should be established in areas of Alaska where frost heave conditions seem to be the worse. Various types of monuments should be installed such as standard pipe, 5/8" rods, 3/4"

rods, and the finned rod. Different materials shall be used such as aluminum, PVC, carsonite, carbon steel, and stainless steel. Installation procedures shall be varied on each monument type and each material type to determine if improper installation may be a contributing factor in the frost heaving of monument. For example: Drive one rod into position by adding as many rod sections as required until the point of refusal has been reached. Drive a second rod of like material into position, but use fewer rods and stop short of refusal. Set one pipe monument and backfill loosely with soft soil. Set a like pipe monument, but tamp the backfill and use gravel and rocks for the backfill material. By making accurate installation records for each monument, future inspections may be able to determine if installation techniques add significantly to frost heaving conditions.

A frost heave test site should be visited at least once a year. Vertical measurement should be taken at each visit and compared to the previous visit. Such a procedure would determine the amount of frost heave on each monument and also show if the installation procedure influenced the amount of frost heave.

It is recommended that test site areas be chosen and frost heave test beds be established by BLM Cadastral Survey.

V. Water Overflow Test Beds:

Both fresh water and salt water overflow conditions will affect monument life.

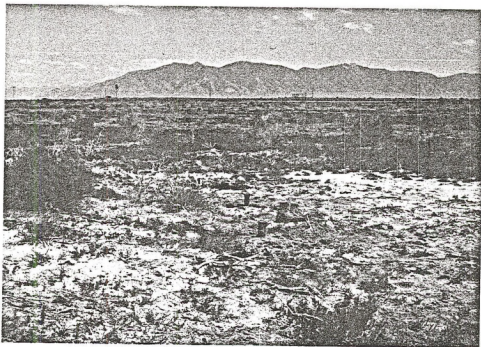
Both a fresh water and salt water test bed should be established. These test sites would allow BLM personnel to study the overflow effects in actual field conditions.

VI. Existing Test Beds:

Photographs of BLM's present test sites may be viewed on the following pages.

MONUMENT TEST SITES

ALKALINE TEST BED SITE



Established in 1962
Located near Salt Lake City, Utah

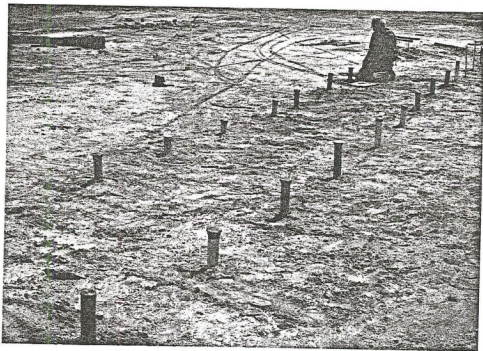
ALKALINE TEST BED SITE



Established in 1962
Located near Hill AFB, Utah



ACID TEST BED SITE



Established in June 1982
Location - Shasta County, California

Note: This site was destroyed by vandalism in 1984.

TEST SITE No. 3

	1	2	3	4	5	6	7	8	9	10	11	12
Line B.	B A-4BR	B A-5	B A-3	H 120	H A-53	H	A	A	A	B	B	A
	○	○	○	○	○	○	○	○	○	●	●	●
	Std. Monu.	SS 304 Sched-5	PVC Sched-80	Std. Monu.	Std. Monu.	SS 304 Sched-5	Anodized Al	Epoxy Coated Al	Al	Al 3/4 Rod	Fiberglass 3/4 Rod	SS 304 5/8 Rod

	H	B	B	B	H	H	H	A	A	A	B	B	A
Line A.	A-120				120	A-53							
	○	○	○	○	○	○	○	○	○	○	●	●	●
	Std.	Std.	SS	PVC	Std.	Std.	SS	Anodized	Epoxy	Al	Al	Fiberglass	SS
	Monu.	Monu.	304	Sched-80	Monu.	Monu.	304	Al	Coated		3/4	3/4	304
	NFS		Sched-5				Sched-5		Al		Rod	Rod	5/8 Rod
	Sched-90												

Soil pH Approx. 3.0

Shasta County, California

(Near old copper mine)

A. -- Allied Manufactured
B. -- Bernsten Manufactured
H. -- Hofland Manufactured

Location:
N $\frac{1}{2}$ of Sect 22, T 34N, R3W
Shasta County, California



Acid-soil test bed destroyed by vandals

PREScribed BURN SITE



Location: Shasta Trinity National Forest
NE 1/4 of Section 14, Township 37 N,
Range 1 E, Mt. Diablo Meridian, California



CHAPTER XI.

MONUMENT REPORTS

Monument Report

I. Introduction:

The survey monumentation program will require writing various types of reports. These reports will be written to cover a variety of subjects such as:

- A. Test Bed Inspections
- B. Quality Control Inspections
- C. Metallurgical Reports
- D. Reports on New Products
- E. Field Problems and Requests
- F. Alerts to Cover Problem Areas
- G. Reports on Independent Research and Study

II. Test Bed Inspection Reports:

At present BLM has two test beds established in alkaline soils. Other test beds have been proposed for acid soils, water overflow areas (both salt and fresh), and freeze-thaw areas.

A report will be required to fully describe the conditions of each test bed inspection by date. Each report must include an accurate description of the corroding conditions of each type monument and each type material within the test bed. Photographs will also be taken of each monument inspected. This recorded information will be maintained as a permanent record at the Denver Service Center, to show how corrosion has progressed on each material type with time. One copy of each inspection report will be forwarded to all State Cadastral Survey offices.

A sample test bed inspection report may be observed in Enclosure 1.

III. Quality Control Inspections:

When quality control inspections are made, the inspector must carefully record all findings. When the inspection has been completed, the inspector must complete a technical report of his findings and forward this report to the area that was inspected. In the event that a problem was discovered, such as monuments that did not meet BLM specifications, an alert notice must be sent to all State Cadastral Survey offices.

IV. Metallurgical Report:

Monument materials will need to be analyzed from time to time for various reasons. A new supplier will be required to have his materials analyzed and quality control inspections will require metallurgical analysis. A field representative may request that their monument materials be analyzed at any time. At a minimum a metallurgical report will include the following:

- A. Material to be analyzed
- B. Manufacturer of the material
- C. Alloying elements that make up the material
- D. The chemical composition percentage of each alloying element
- E. A conclusion statement as to whether the material meets BLM specifications, exceeds BLM requirements, or does not meet BLM requirements.

A sample metallurgical report may be observed in Enclosure 2.

V. Reports on New Products:

One important aspect of monumentation is to study and stay abreast of state-of-the art research as related to corrosion resistant materials. As new improved materials are developed, they must be related to cadastral survey requirements. When materials seem suitable for BLM cadastral needs, a report should be issued to all cadastral survey offices for their review and to keep all offices updated. In addition to reporting on these new materials, a sample of each material should be placed in BLM test beds for actual field monitoring.

VI. Field Problems and Requests:

From time to time BLM field survey personnel may have problems relating to monumentation. These problems may be in regards to corrosion, installation procedures, stamping data onto the monuments, frost heave, tools, accessories, or others. The Denver Service Center has engineering talent available to assist field personnel with their problems. When

problem areas are identified, a thorough investigation will be made by a qualified representative. Whether the problems are solved or not, a complete report will be issued to identify the problems and describe the work that was performed on each problem area. When problems are corrected, this information will be included in the report and a copy of these reports will be sent to all cadastral state offices.

VII. Alerts to Cover Problem Areas:

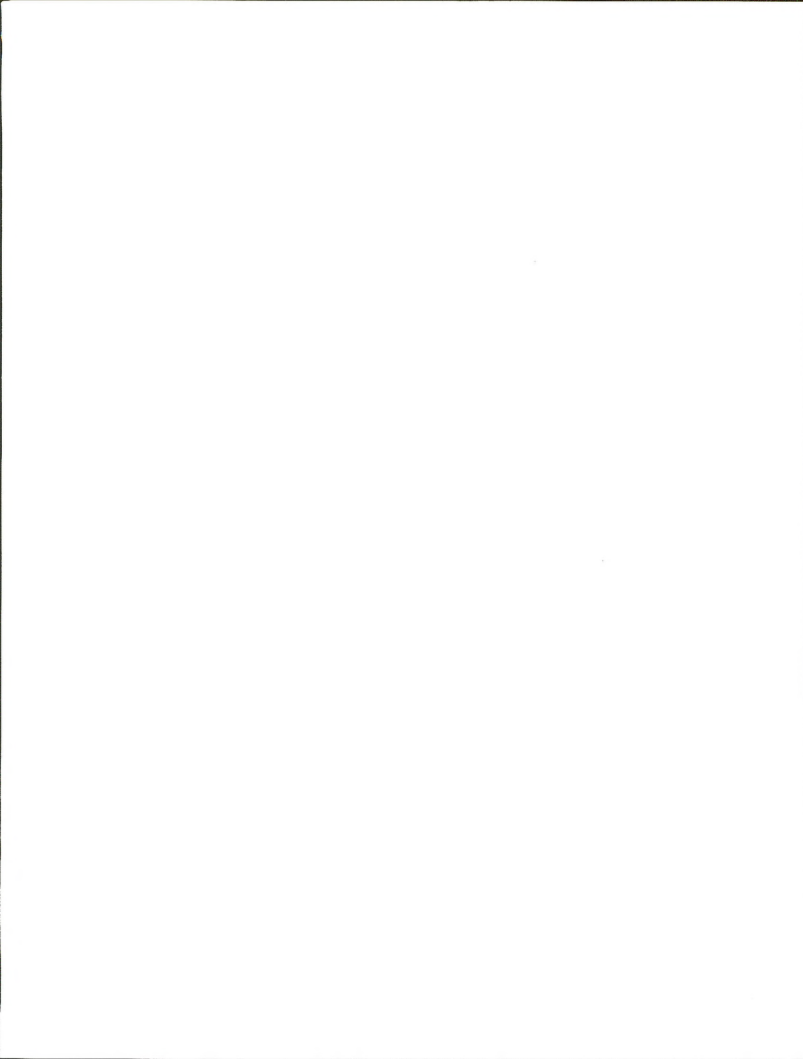
Alert messages are very important and should be issued from an office of authority. For this reason alert messages will normally be issued from the Washington Office. In regards to monumentation, however, a field inspection may uncover a manufacturer that is supplying inferior products. If such a condition is discovered, the inspecting officer must prepare a technical report spelling out the problem and the recommended solution. This technical trouble report will be forwarded to the Washington Office for review. Washington will then make the decision as to whether or not an alert message will be sent out to all State Offices.

VIII. Reports on Independent Research and Study

From time to time independent research studies have been requested for survey monumentation. These studies may vary in subject matter but may cover, frost heave problems, corrosion progression, installation techniques, etc. When these studies are completed they will always be followed by a complete record. These reports will be submitted to all BLM State Offices.

A sample of this type report may be reviewed in Enclosure 3.

APPENDIX



COMPILATION OF LITERATURE REFERENCES

1. "Standard Handbook for Mechanical Engineers" - Seventh Edition
Lionel S. Marks
Theodore Baumeister
2. "Aluminum Culvert Corrosion Technical Paper 76-5"
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Department of Transportation
Augusta, Maine
3. "Geology of Soils"
Charles B. Hunt
John Hopkins University
4. "Soil Physics - Fourth Edition"
L.D. Bayer
Ohio State University
5. "Intergranular Corrosion of Stainless Alloys"
R.F. Steigerwald
American Society for Testing and Materials
6. "Galvanic and Pitting Corrosion"
Babian/France/Rowe/Ryniewicz
American Society for Testing and Materials
7. "Soil Survey of El Paso, County, Colorado"
U.S. Department of Agriculture
Soil Conservation Service
8. "Permanent Monumentation Study"
Richard B. Case
Bureau of Land Management
9. "Manual of Instructions for the Survey of
the Public Lands of the United States"
General Land Office - 1930
10. "Clark on Surveying and Boundaries" - Third Edition
John S. Grimes

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